FINAL SUBMITTAL

EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS PROGRAM
BAMBERG MILITARY COMMUNITY
GERMANY

Prepared for

DEPARTMENT OF THE ARMY

EUROPE DIVISION, CORPS OF ENGINEERS

FRANKFURT, GERMANY

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DEPARTMENT OF THE ARMY
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SECTION A.0

EXECUTIVE SUMMARY

A.1 INTRODUCTION OF PROJECT

This Executive Summary outlines the results of all work for the Energy Engineering Analysis Program (EEAP), Bamberg Military Community, Germany. This work was authorized under contract number DACA 90-82-C-0204 with the U.S. Army Corps of Engineers, Europe Division, Frankfurt A/M, Germany.

The primary purpose of the Energy Engineering Analysis Program was to develop Energy Conservation Investment Program (ECIP) projects that comply with the objectives set forth in the Army Facilities Energy Plan.

The work was performed in three phases: Phase I consisted of data gathering and inspection of facilities culminating in a data report; Phase II included energy data analysis, evaluation of the technical and economic feasibility of energy conservation opportunities, and completion of the front pages of DD Forms 1391; Phase III included preparation and completion of DD Forms 1391, including detailed justifications and project development brochures (PDB-I's).

The following increments of work were authorized in the scope of services:

- Increment A: Buildings and processes
- Increment B: Utilities and energy distribution systems, Energy Monitoring and Control Systems (EMCS), and use of waste fuels in existing energy plants.
- Increment F: Facilities Engineer funding authority energy conservation projects.

- Increment G: Energy conservation projects found viable but that do not meet ECIP criteria.

A.2 EXISTING ENERGY SITUATION

A.2.1 Baseline FY75 Energy Consumption

Total USMC Bamberg energy consumption by source for FY75 has been reported as follows:[1/]

Electricity	157,667	$\times 10^6$ BTU
Anthracite coal	260,838	$\times 10^6$ BTU
Bituminous coal	49,389	$\times 10^6$ BTU
No. 2 fuel oil	228,163	$\times 10^6$ BTU
Natural gas	14,440	$\times 10^6$ BTU
Liquid propane gas	4,114	$\times 10^6$ BTU
Purchased steam & hot water	5,096	$\times 10^6$ BTU
TOTAL	719,707	$\times 10^6$ BTU
Revised Total	786,279	$\times 10^6$ BTU

A.2.2 Present Annual Energy Consumption

Total energy consumption of USMC Bamberg in FY82 of non-transportation energy sources was 990,108 million BTU. A breakdown in FY82 energy consumption and cost by source is shown in the following table:

[1/] Source: Community Facilities Energy Plan, USMC Bamberg. Revised total per 23 March 1982 letter from 7th Corps.

ENERGY SOURCE	QUANTITY	MBTU	AVERAGE COST/MBTU 1/ DOLLARS (DM 2.40=$1)
Natural Gas	303,020 Therms	30,302	10.13
Liquid Propane Gas	48,968 Gallons	4,652	9.27
No. 2 Fuel Oil	1,776,624 Gallons	242,928	7.23
Purchased Steam	6,500 MBTU	6,500	14.22
Coal, Bituminous (Med. Vol)	3,124 Metric Tons	91,366	5.54
Coal, Bituminous (High Vol)	2,561 Metric Tons	73,623	4.10
Coal, Anthracite	10,790 Metric Tons	307,748	6.75
Electricity	20,085 MWH	232,989	6.72

1/FY82, 4th quarter

The relative consumption by energy source is shown graphically in Figure A-1.

The breakdown in source energy consumption for FY82 by GY area is shown in Table A-1.

A.2.3 Energy Consumption by End Use and Building Function

The breakdown in source energy consumption by end use is shown in Table A-2. The breakdown in source energy consumption by facility function is shown in Table A-3. The relative consumption by energy use and facility function is shown graphically in Figure A-2.

A.2.4 Typical Building Energy Consumption

A breakdown in estimated FY82 energy consumption by end use (lighting, space heating, domestic hot water heating and process loads) for typical buildings representative of all facilities at USMC Bamberg is shown in Table A-11.

A.3. ENERGY CONSERVATION OPPORTUNITIES DEVELOPED

A.3.1 Energy Conservation Opportunities Investigated

A summary of all potential energy conservation opportunities (ECO's) considered for implementation at USMC Bamberg is presented in Table A-4. A matrix of reasons for eliminating certain ECO's from further consideration is included in Table A-4.

A.3.2 ECIP Projects Developed

During the Phase II effort, documentation was developed for twenty-five ECO's, including many that did not meet the ECIP $200,000 funding minimum. A set of project combinations to attain the ECIP funding minimum were proposed and accepted at the Phase II presentation at USMC Bamberg. The following paragraphs describe these recommended ECIP project combinations.

1. ECIP: Install Heating Plant Insulation, Controls and Waste Heat Recovery includes the following retrofit measures:
   a. Install and repair insulation within heating plants on valves, boilers, vessels, tanks, and piping.
   b. Install continuous boiler blow-down controls with waste heat recovery.
   c. Install hot condensate heat recovery equipment.
   d. Isolate off-line boilers.
   e. Install oxygen trim boiler combustion controls.

2. ECIP: Building Heating Controls Upgrade includes the following retrofit measures:

   a. Install night and weekend temperature setback controls and thermostatic radiation control valves.

   b. Install outside air temperature reset of heating hot water supply.

   c. Provide separate source of make-up air for kitchen exhaust hoods.

3. ECIP: Weatherize MCA Facilities includes the following measures:

   a. Weatherstrip and caulk doors and windows.

   b. Install roof insulation.

   c. Replace single pane windows with dual glazed windows.

4. ECIP: Lighting System Improvements includes the following measures:

   a. Install more efficient lighting fixtures.

   b. Install time control of lighting panels.

A.3.3 Other Energy Conservation Projects Developed

All Increment F projects identified during Phase II--except those that were deleted from the combined projects at the request of USMC Bamberg DEH or those Increment F combinations that fall below the $200,000 lower funding limit--have been combined into ECIP projects. No projects identified during this study fall into the Increment G category. Recommended energy conservation projects that fall within the $200,000 funding authority of the Facilities Engineer are summarized in Table A-5.

Complete programming documentation also was prepared for a project to repair leaks and insulation in central heating plant distribution piping that did not meet the minimum level for ECIP funding.

A.3.4 Recommended Policy and Operations Changes

The following policy changes and new policies are recommended for implementation by the military community:

- Laundry Dryer Usage: Laundry dryers in family housing dwellings are electric clothes dryers. A considerable electric demand charge reduction could be realized if these dryars were not used during peak demand periods. It is recommended that a directive be prepared by appropriate authority prohibiting their usage during these periods.
- Barracks Lighting During Non-Occupied Periods: Field investigations for this study indicate that many lights in unoccupied rooms were left on. It is recommended that a directive be prepared by appropriate authority to require that lighting circuits be turned off at panelboards for each section of barracks buildings during schedules times of non-occupancy. (Exceptions should be allowed for personnel that must remain in their rooms for authorized reasons).

The energy conservation policies, plans, and support currently in place at LSMC Bamberg are to be commended. Documented energy savings have been realized, and the energy awareness of all community personnel has been heightened.

The following changes in standard operating procedures are recommended for implementation by the military community:

- Turning off Services to Barracks During Field Rotations: It is recommended that all utility services, including lighting, electrical and heating, be turned off in sections of barracks buildings normally occupied by a company that is assigned to field training or BOP service. Personnel left behind for authorized reasons should be temporarily assigned to another room in an (currently) occupied section of the barracks during these periods. (Heating systems should be maintained at a low level of heating during freezing weather to prevent freezing of pipes, etc.)
- Group Relamping: It is recommended that a group relamping program with relamping targeted for 70 percent of rated lamp life be initiated. (See Section 11.0 for details.)
- Boiler Plant Operations: No revisions to present boiler operations are recommended. Considering the age and condition of many boiler plants within the community operations procedures currently in effect provide near-optimal service.

The following suggestion concerns an issue outside the authority of the military community: Coal shipped from the United States comes to Europed with a relatively high content of inert material. The quality of this coal is considerably below that normally available in the United States. The command should consider:

- Revising the specification for this coal, or
- Providing a central cleaning facility at a transshipment point either in the United States or in Europe, or
- Allowing local domestic (foreign) suppliers to submit competitive bids for supplying coal.

A.4 ENERGY AND COST SAVINGS

A.4.1 Energy Consumption Forecast After Total Project Implementation

Monthly energy use profiles for FY82 and projected after implementation of all recommended projects are shown graphically in Figure A-3. Projected energy consumption by end use with conservation measures implemented is summarized in Table A-6. Projected energy consumption by facility function with conservation measures implemented is summarized in Table A-7.

A.4.2 Projected Utility Costs

Projected utility costs for USMC Bamberg are summarized in Table A-8.

A.4.3 Schedule of ECIP Projects

A summary of ECIP project data for USMC Bamberg is provided in Table A-9.

A.5 SUMMARY AND CONCLUSIONS

This EEAP study for USMC Bamberg has provided the following data and deliverables for use by the community in preparing its energy conservation plan and attaining its energy conservation goals:

- Historical energy consumption of all USMC Bamberg GY areas.
- Energy consumption by each facility function and end use.
- Energy simulations of 16 typical buildings using the B.L.A.S.T. computer program.

- Documentation for ECO's that should not be accomplished because of insufficient economics.
- Complete DD Forms 1391 and PDB-1's for six ECIP projects and one Increment F project totaling $2,972,200 in construction cost.

Implementation of all energy conservation projects recommended in this EEAP Study as well as retrofits recently accomplished by the community would result in an overall energy savings of 19 percent1/ from FY75 consumption. (See Table A-10.) This amount marginally meets the savings goal for FY85 of 20 percent.

1/Per square feet of active facilities.

- Documentation for ECO's that should not be accomplished because of insufficient economics.
- Complete DD Forms 1391 and PDB-1's for six ECIP projects and one Increment F project totaling $2,972,200 in construction cost.

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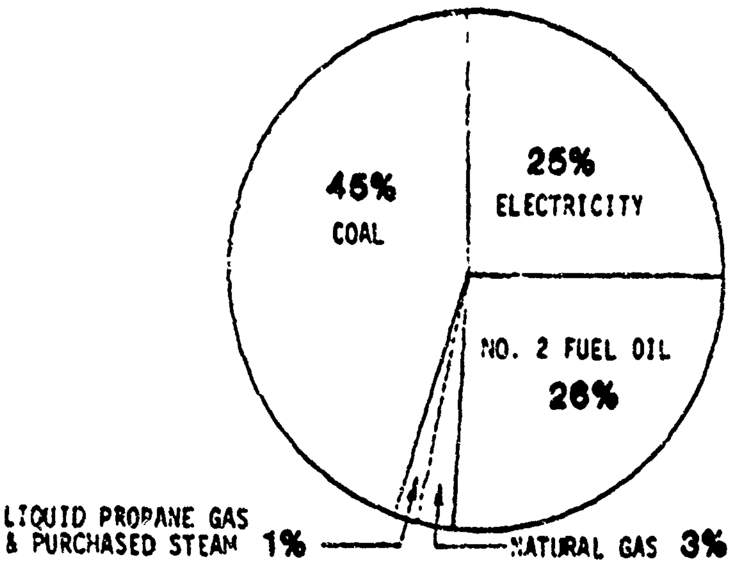
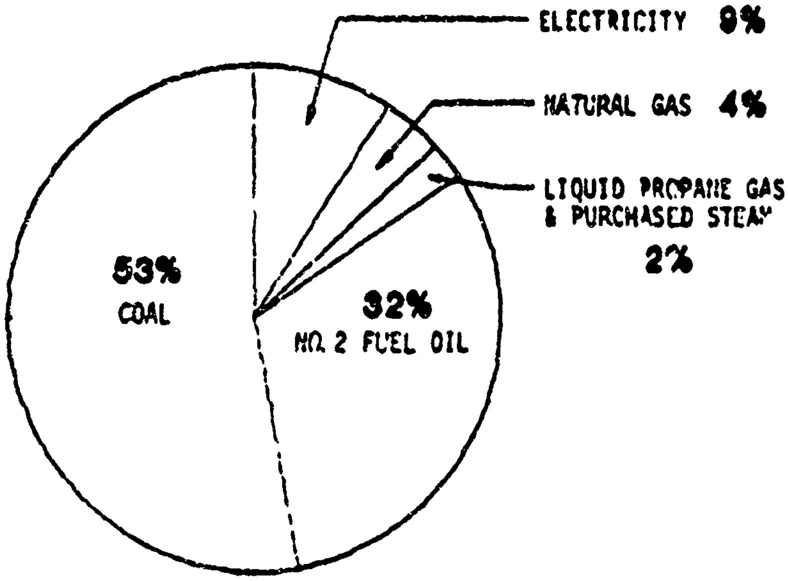
[1] Per square feet of active facilities.

FACILITIES ENERGY CONSUMPTION BY SOURCE
USMC BAMBERG



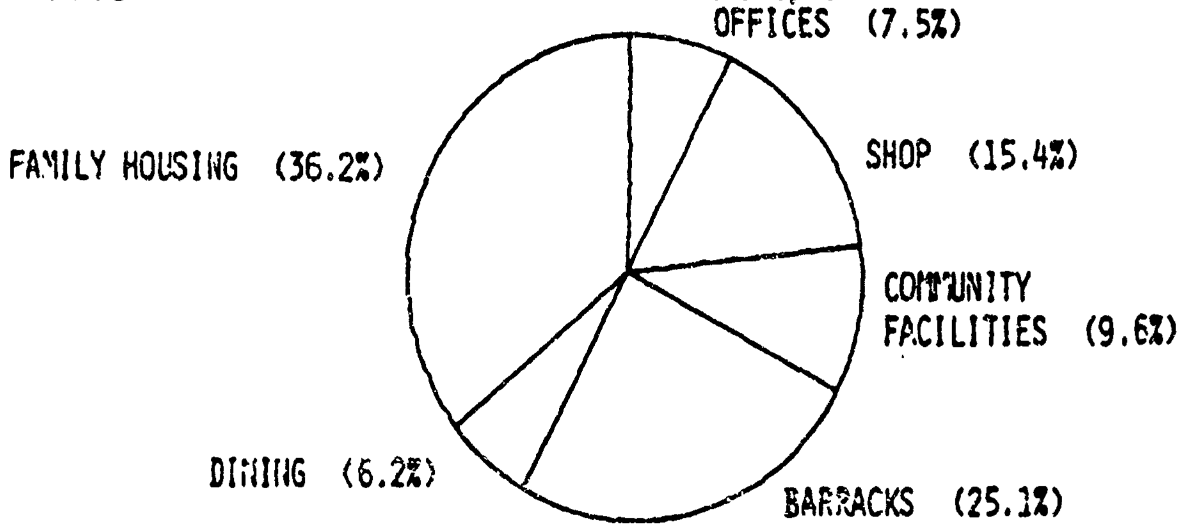
FY 82 FACILITIES ENERGY CONSUMPTION
(ELECTRICITY CONVERTED USING 11,600 BTU/KWH)



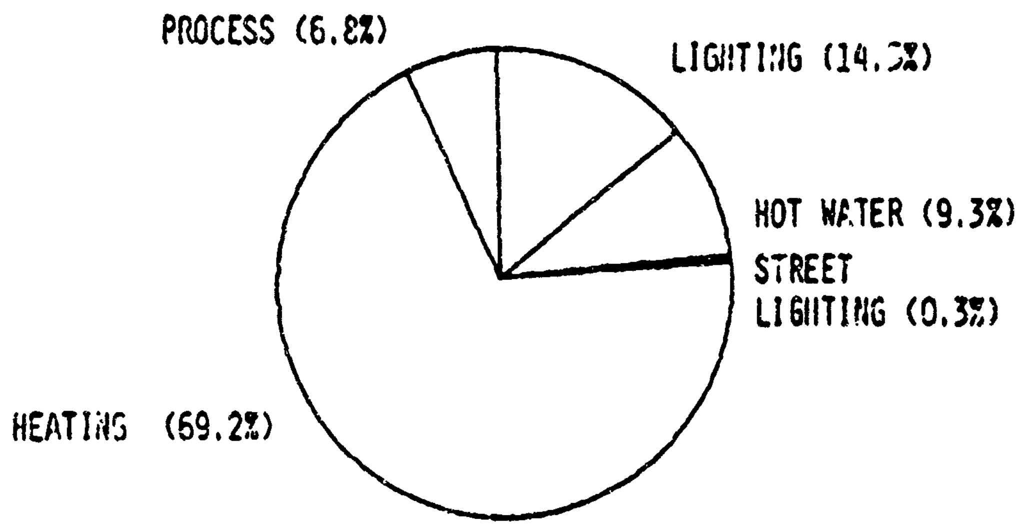
FY 82 FACILITIES ENERGY CONSUMPTION
(ELECTRICITY CONVERTED USING 3,413 BTU/KWH)

FIGURE A-1

FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION AND END-USE, USMC BAMBERG



FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION



FY82 ENERGY CONSUMPTION BY END-USE

FIGURE A-2

SUMMARY: MONTHLY ENERGY USE PROFILES FOR FY82 AND PROJECTED ENERGY CONSUMPTION

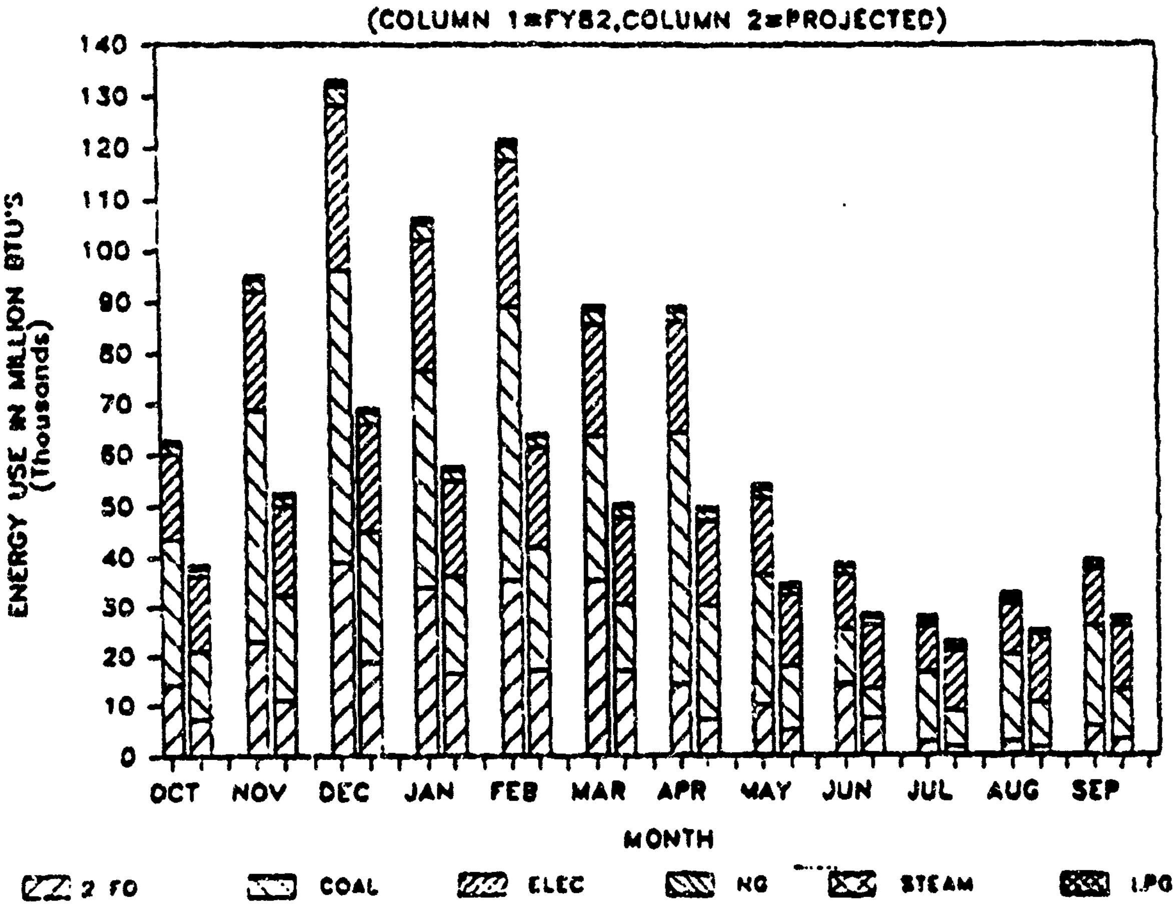


FIGURE A-3

FY82 ENERGY CONSUMPTION BY GY AREA (10^6 BTU) - USMC BAMBERG

GY AREA/DESCRIPTION	NATURAL GAS 1/	LIQUID PROPANE GAS 2/	NO. 2 FUEL OIL 3/	PURCHASED STEAM	COAL 4/ BITUMINOUS (MED. VOL)	COAL 4/ BITUMINOUS (HI VOL)	COAL 4/ ANTHRACITE	ELECTRICITY 5/	TOTAL ENERGY CONSUMPTION
GY 009: AIRFIELD	-	-	1,726	-	-	-	-	162 7/	1,888
GY 039: AMMO DEPOT (FMNA)	6/	6/	18,526	-	-	-	1,870	12,470 7/	32,866
GY 093: KINGSLEY BARRACKS, HOF	160 7/	-	1,233	6,500 7/	-	-	-	6,640 7/	12,533
GY 150: FLYNN HOUSING AND SCHOOL	18,043	-	42,087	-	76,609	1,450	14,036	55,682	199,915
GY 175: COBURG/KRONACH HOUSING	35	-	2,006	-	-	-	-	312	2,353
GY 230: PINES HOUSING	6/	-	17,276	-	-	-	12,831	6/	30,107
GY 324: HARRIS BARRACKS, COBURG	363	-	11,140	-	-	-	-	3,083	14,586
GY 665: WARNER BARRACKS I, II, III	14,046	4,652	135,573	-	14,757	2,122	271,856	139,632	583,038
GY A46. SCHWEINFURT/ASSMANLOS TAC OFF SITE	-	-	1,625	-	-	-	-	11,690	13,315
GY 695: LEASED HOUSING	5,255	-	11,736	-	-	70,043	7,155	5,318	99,507
TOTAL	30,302	4,652	242,928	6,500	91,366	73,623	307,748	232,989	990,108

1/ HEATING VALUE 1.031 x 10^6 BTU/1,000 CU.FT.
2/ HEATING VALUE 95,000 BTU/GALLON.
3/ HEATING VALUE 138,692 BTU/GALLON
4/ ANTHRACITE 28.5 x 10^6 BTU/METRIC TON.
BITUMINOUS (MED. VOLATILE) 29.25 x 10^6 BTU/METRIC TON.
BITUMINOUS (HI VOLATILE) 28.75 x 10^6 BTU/METRIC TON.

5/ SOURCE CONVERSION 11.6 x 10^3 BTU/KWH.
6/ INCLUDED IN CONSUMPTION FOR GY 665.
7/ ESTIMATED, DATA NOT COMPLETE.

SOURCE: USMC BAMBERG BEN RECORDS.

TABLE A-1

SUMMARY OF FY82 ENERGY CONSUMPTION BY END USE: USMC BAMBERG[1/]

ENERGY USAGE CATEGORY	ENERGY USE ESTIMATE FOR FY 82 (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Space Heating	344,285	203,624	8,461	-0-	6,017	54,224	616,612
Domestic Hot Water	48,586	25,626	363	4,652	422	2,902	82,551
Process Consumption	2,668	1,942	16,222	-0-	61	39,463	60,356
Lighting-Inside	-0-	-0-	-0-	-0-	-0-	128,762	128,762
Lighting-Outside / Street	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	395,539	231,192	25,047	4,652	6,500	227,671	890,601

1/ Leased housing is not included.

TABLE A-2

SUMMARY OF FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION: USMC BAMBERG[1/]

BUILDING FUNCTION	ENERGY USE ESTIMATE FOR FY 82 (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Offices and Administration	33,512	14,465	1,795	-0-	-0-	16,732	66,504
Shops and Maintenance	4,794	56,637	4,755	-0-	-0-	10,798	136,985
Barracks and Quarters	105,687	51,956	95	4,652	5,839	54,961	223,190
Community Facilities	46,910	16,137	2,794	-0-	-0-	19,230	85,071
Dining Facilities & Clubs	17,825	20,382	3,247	-0-	661	13,132	55,248
Family Housing	126,810	71,615	12,361	-0-	-0-	110,497	321,283
Utilities - Street Lighting	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	395,539	231,192	25,047	4,652	6,500	227,671	890,601

1/ Leased housing is not included.

TABLE A-3

SUMMARY OF ECO EVALUATIONS FOR USMC BARRACKS

DESIGNATION	DESCRIPTION OF ECO	ECIP 1/	INCREMENT "G"	INCREMENT "F"	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
1A	Reduce Equipment Operating Hours							•
2A	Reduce Load Due to Ventilation				•			
3A	Night Set-Back (& Weekends) Thermostatic Controls	•						
3B	Install Dead-Band Thermostats				•			
3C	Install Steam Humidification for Building 7334					•		
4A	Reduce DHW Temperatures			•				
4B	Install Flow Restriction Devices			•				
4C	Install Self-Closing Valves				•			
5A	Isolate Off-Line Boilers	•						
6A	Segregate Areas @ No or Lower Conditioning Levels			•				
7A	Reduce Lighting Levels (Delamp, Relocate)			•				
8A	Reduce Lighting Usage (Photo Cells, Task Switching, Time Clocks)	•						
9A	Use Natural Light (Sky Lights & Clerestory Windows)					•		
10A	Reduce Lamp Wattages			•			•	
10B	Remove/Replace Diffusers and/or Lenses							•
10C	Improve Room Wall & Ceiling Reflectance				•			
10D	Group Relamping Programs						•	
11A	Install More Efficient Lamps						•	
12A	Install More Efficient Lighting Fixtures	•						
13A	Install More Efficient Ballasts					•	•	
14A	Install Wall Insulation					•		
14B	Install New Insulated Maintenance Bay Doors					•		
15A	Install Dual Glazed Windows	•						
16A	Install Roof or Ceiling Insulation	•						

1/ Denotes that ECO is included as part of an ECIP project.

TABLE A-4

SUMMARY OF ECO EVALUATIONS FOR USMC BAMBERG

DESIGNATION	DESCRIPTION OF ECO	ECIP[1]	INCREMENT "G"	INCREMENT "F"	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
17A	Install Floor Insulation					•		
18A	Caulk and Weather-Strip Around Doors and Windows	•		•				
18B	Provide Air Curtains on Frequently Used Doors				•			
18C	Install Building Vestibules				•			
19A	Remove (Maintain) Resistances to Air Flow				•			
20A	Reduce Flow Resistance in Liquid Pumping Systems							•
21A	Repair &/or Replace Boiler Plant Piping & Insulation	•						
21B	Insulate Valves in Boiler Plants	•						
21C	Repair, Replace, Install Boiler & Vessel Insulation	•						
22A	Fix Leaks & Insul. in Central Plant Distrib. Systems			•				
23A	Replace Steam Traps							•
24A	Convert Heating Systems to More Efficient Media					•		
25A	Install Thermostatic Radiator Control Valves	•		•				•
26A	Outside Air Temp Resets on HW Heating	•						
26B	Provide Zone Controls for Buildings				•			
27A	Install Economizers on AHU Systems				•			
28A	Use Separate Make-Up Air for Exhaust Hoods	•						
29A&B	Use Radiant Heating in High Infiltration Areas					•		
30A	Reduce Energy Consumption in Double Duct Systems				•			
31A	Replace Existing with Modular or Auto-Feed Boilers				•			
32A	Reclaim Heat from Flue Gasses to Preheat Comb. Air				•			
33A	Install Flue Gas Economizers (Preheat Feed Water)					•		•
33B	Install Oxygen Trim Boiler Combustion Controls	•						

1/ Denotes that ECO is included as part of an ECIP project.

TABLE A-4

SUMMARY OF ECO EVALUATIONS FOR USMC BAMBERG

DESIGNATION	DESCRIPTION OF ECO	ECIP 1/	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
33C	Replace Inefficient with More Efficient Burners					•		
33D	Install Turbulators in Fire-Tube Boilers				•			
33F	Replace Steam with Air-Atomizing Burners					•		
34A	Install Automatic Boiler Blow-Down Controls	•						
34B	Recover Heat from Boiler Blow-Down	•						
35A	Utilization of Heat Reclamation Systems							•
36A	Insulate DHW Distribution Piping within Buildings				•			
37A	Heat Recovery (Hot Gas Exch.) from Laundry Dryers			•				
37B	Hot Drain Exchangers for Laundries & Kitchens			•				
37C	Hot Condensate Heat Recovery (Flash Steam)	•						
38A	Decentralize DHW Service - Non-Heating Season			•				
39A	Solar DHW Heating Systems					•		
40A	Curtail Availability of DHW			•				
41A	Reduce Energy Consumption of Equip. & Machines							•
42A	Reduce Peak (Electrical Loads)							•
43A	Utilize More Efficient Transformers				•			
44A	Replace Oversized Motors						•	
45A	Correct Power Factor			•				2/
46A	Energy Management & Control System(s) (EMCS)							
46B	Power Line Carrier System					•		
47A	Reschedule/Consolidate Utilization of Facilities				•			
48A	Connect to District Heating to Purchase Energy				•			
49A	Install Family Housing Unit Energy Metering						•	

1/ Denotes that ECO is included as part of an ECIP project.

2/ Individual building retrofits recommended rather than EMCS.

TABLE A-4

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC BAMBERG

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10^6 BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT				SIR
					MATERIAL COST	MANHOURS		TOTAL COST (US $)	
						TRADE	HOURS		
REDUCE DHW TEMPERATURES	98 BUILDINGS	1,918	135,763	1,893,384	15,240	MECHANIC	261	22,390	84.24
REDUCE AVAILABILITY OF DHW	14 BUILDINGS	2,730	19,277	268,641	6,670	ELECTRICIAN	122	10,221	26.19
REDUCE DHW TEMPERATURE: FAMILY HOUSING	68 BUILDINGS	381	83,134	1,112,948	47,958	MECHANIC	472	55,909	19.84
REDUCE AVAILABILITY OF DHW: FAMILY HOUSING	30 BUILDINGS	5,474	39,030	457,448	15,392	ELECTRICIAN	280	23,587	19.33
INSTALL FLOW RESTRICTING SHOWER HEADS AND LAVATORY FAUCET INSERTS	102 BUILDINGS	6,940	45,503	648,623	20,457	PLUMBER	759	50,792	12.83
REMOVE UNNECESSARY LIGHT FIXTURES	32 BUILDINGS	3,599	20,195	266,220	-0-	ELECTRICIAN	553	21,316	12.50
REPAIR LEAKS & INSULATION IN CENTRAL PLANT DIST. PIPING	14 CENTRAL HEATING PLANTS	10,374	96,612	1,356,919	44,450	PIPE FITTER	2,502	120,137	11.25
REPLACE BROKEN WINDOW GLASS	23 BUILDINGS	496	143	5,985	374	GLAZIER	23	965	6.20
INSTALL FLOW RESTRICTING SHOWER HEADS & LAVATORY FAUCET INSERTS: FAMILY HOUSING	65 BUILDINGS	3,774	25,700	300,919	33,227	PLUMBER	860	50,301	5.90
FIX LEAKS IN BOILER PLANT PIPING	3 BUILDINGS	42	709	3,926	558	PLUMBER AND PLUMBER'S HELPER	6	834	4.71
INSTALL ROOF INSULATION: FAMILY HOUSING	BUILDINGS 2657, 8389, 3658, 8657	787	5,238	75,491	6,938	CARPENTER	340	17,313	4.35

TABLE A-5

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC BAMBERG

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10^6 BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT: MATERIAL COST	COST TO IMPLEMENT: MANHOURS: TRADE	COST TO IMPLEMENT: MANHOURS: HOURS	COST TO IMPLEMENT: TOTAL COST (US $)	SIR
DECENTRALIZE DHW SERVICE DURING NONHEATING SEASON	BUILDINGS 7644, 7645, 7649 IN GY 150	1,213	7,873	121,189	22,134	STEAM FITTER	205	28,090	4.30
LAUNDRY WATER WASTE HEAT RECOVERY	BUILDINGS 7047 AND 7098 IN GY 605	2,036	14,238	170,658	38,330	PLUMBER	415	42,321	4.21
CAULK AND WEATHERSTRIP DOOR AND WINDOW OPENINGS: FAMILY HOUSING	9 BUILDINGS	1,290	8,502	128,969	16,767	CARPENTER	493	31,853	4.03
LAUNDRY DRYER WASTE HEAT RECOVERY	BUILDINGS 7047 AND 7098 IN GY 605	609	4,690	58,351	15,362	SHEET METAL WORKER	193	20,717	2.01
INSTALL AUTO-CLOSING DEVICES ON EXTERIOR DOORS	10 BUILDINGS	282	1,979	24,716	7,443	CARPENTER	113	10,437	2.37
INSTALL DUAL-GLAZED WINDOWS: FAMILY HOUSING	BUILDING 7703	387	2,505	39,276	6,554	GLAZIER	436	19,650	1.99
INSTALL PHOTO CONTROL CELLS AND FLUORESCENT LAMPS IN EXTERIOR FIXTURES	214 BUILDINGS	3,769	18,666	205,513	38,078	ELECTRICIAN	2,650	110,615	1.73
INSTALL POWER FACTOR CORRECTION CAPACITORS	6 TRANSFORMER STATIONS	0	25,060	235,585	127,484	ELECTRICIAN	1,134	161,934	1.44
REPLACE EXTERIOR LIGHTING FIXTURE WITH PHOTOCELL-CONTROLLED FLUORESCENT FIXTURE	33 BUILDINGS	305	1,742	19,179	11,861	ELECTRICIAN	196	17,800	1.08

TABLE A-5

SUMMARY OF ENERGY CONSUMPTION BY END USE

WITH CONSERVATION PROJECTS IMPLEMENTED: USMC BAMBERG 1/

ENERGY USAGE CATEGORY	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Space Heating	209,020	127,320	5,070	-0-	3,862	23,930	369,202
Domestic Hot Water	28,470	15,680	300	3,375	424	1,320	49,569
Process Consumption	2,530	1,580	16,222	-0-	61	39,460	59,853
Lighting-Inside	-0-	-0-	-0-	-0-	-0-	119,455	119,455
Lighting-Outside / Street	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	240,020	144,580	21,592	3,375	4,347	186,485	600,399

1/ Leased housing and new facilities are not included. Energy Savings include projects recommended by this EEAP study plus projects completed or programmed by the military community.

TABLE A-6

SUMMARY OF ENERGY CONSUMPTION BY FACILITY FUNCTION
WITH CONSERVATION MEASURES IMPLEMENTED: USMC BAMBERG 1/

BUILDING FUNCTION	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)						
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	TOTAL
Offices and Administration	13,350	9,730	1,060	-0-	-0-	14,528	38,668
Shops and Maintenance	25,140	26,000	2,883	-0-	-0-	8,357	62,380
Barracks and Quarters	98,690	43,165	95	3,375	3,686	48,749	197,760
Community Facilities	35,310	6,825	2,532	-0-	-0-	17,815	62,482
Dining Facilities & Clubs	6,710	11,750	3,247	-0-	661	11,606	33,974
Family Housing	60,820	47,110	11,775	-0-	-0-	83,110	202,815
Utilities - Street Lighting	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	240,020	144,580	21,592	3,375	4,347	186,485	600,399

1/ Leased housing and new facilities are not included. Energy Savings include projects recommended by this EEAP study plus projects completed or programmed by the military community.

TABLE A-7

PROJECTED UTILITY COSTS - USMC BAMBERG

ENERGY SOURCE	AVERAGE COST/MBTU IN DOLLARS (DM 2.40 = $1.00)1/			
	ACTUAL FY82	PROJECTED FY85	PROJECTED FY90	PROJECTED FY95
Natural Gas	10.13	12.94	13.91	15.80
Liquid Propane Gas	9.27	11.84	12.73	14.46
No. 2 Fuel Oil	7.23	7.79	8.89	12.14
Coal	6.49 2/	7.75	8.46	8.71
Electricity	6.72	7.84	8.20	8.11

ENERGY CONVERSIONS:

Electricity . . . . 11,600 Btu/kWh
Anthracite Coal . . . . 28.50×10^6 Btu/metric ton
Bituminous (Med. Vol) Coal . . . 29.25×10^6 Btu/metric ton
Bituminous (High Vol) Coal . . . 29.75×10^6 Btu/metric ton
No. 2 Fuel Oil . . . . 136,582 Btu/gallon
Natural Gas . . . . 3,413 Btu/kWh (10,760 kWh/m³)
Liquid Propane Gas . . . . 95,000 Btu/gallon (4.43 lbs/gallon)

1/ Based on DOE mid-term energy forecasts (commercial sector) for average of U.S. prices, exclusive of general inflation.
2/ Consumption-weighted average of all coal types.

TABLE A-8

SUMMARY OF ECIP PROJECT DATA FOR USMC BAMBERG

PROJECT TITLE	ENERGY SAVINGS (10^6 BTU/YEAR)	ANNUAL COST SAVINGS (DOLLARS)	TOTAL REQUEST FY 87 ($1,000)	SAVINGS-TO-INVESTMENT RATIO	REFERENCE SECTION (VOL. I)
ECIP: Building Heating Controls Upgrade	71,269	483,557	861.0	10.18	10.3.2
ECIP: Install Heating Plant Insulation, Controls and Waste Heat Recovery	28,707	185,215	516.0	6.54	10.3.1
ECIP: Weatherize MCA Facilities	35,561	240,824	1,197.1	3.73	10.3.3
ECIP: Lighting Systems Improvements	3,955	30,480	240.3	1.78	10.3.4

TABLE A-9

SUMMARY OF FACILITIES ENERGY CONSUMPTION - USMC BAMBERG[1/]

PARAMETER	FY75	FY80	FY81	FY82	FY85
Total Energy Usage (10^6 BTU)	786,279[2/]	976,776	951,093	990,108	701,696
Active Facility Area (10^3 SF)[3/]	5,209	5,539	5,633	5,673	5,740
Energy Use/SF (10^3 BTU/SF)	150.9	176.3	168.8	174.5	122.2
Percent Increase (Decrease)[4/]	--	16.8	11.9	15.7	(19.0)

1/ Includes estimates of energy savings from facility funded projects and those recommended in this document plus planned new construction.
2/ Actual FY75 consumption was 719,707 x 10^6 BTU (including leased housing). Revised figure was provided by VII Corps in letter of 23 March 1982 to account for energy conservation projects implemented before FY75.
3/ Includes leased housing.
4/ Percent increase (decrease) based on FY75 value and usages per square foot

TABLE A-1(

TYPICAL BUILDING ENERGY CONSUMPTION

USMC BAMBERG

FUNCTION	BUILDING NO.	GY AREA	FY 82 ESTIMATED ENERGY CONSUMPTION (MBTU)					GROSS S.F.	KBTU/SF PER YEAR
			LIGHTING	SPACE HEATING	DHW HEATING	PROCESS	TOTAL		
Administration	7088	685	1,182	4,235	43	42	7,077	36,464	194.1
Barracks	7006	685	757	2,191	1,388	175	4,511	23,357	193.1
Motor Repair Shop	7012	685	147	4,040	104	56	4,347	16,490	263.6
Dining	7070	150	1,523	1,595	391	840	4,349	17,478	248.8
Family Housing	7630	150	1,295	3,158	311	507	5,260	31,878	165.0
High School	7643	150	1,514	11,012	347	2,278	15,151	54,978	275.6

TABLE A-11

Volume I: Energy Report

Revision Instructions

1. Replace title sheet.

2. Completely replace Section A.0.

3. In Section 6.0, replace the following like-numbered pages: 6-3, 6-4, 6-6, 6-7, and 6-8.

4. In Section 6.0, replace the following like-numbered pages: Table 7-3 and Table 7-4.

5. In Section 10.0, replace the following like-numbered pages: 10-9, 10-11 through 10-26, Table 10-1, sheets 2 and 3. Delete page 10-27.

6. In Section 11.0, replace the following like-numbered pages: 11-4 through 11-9, Table 11-1, sheets 1 and 2.

FINAL SUBMITTAL

VOLUME I: ENERGY REPORT

ENERGY ENGINEERING ANALYSIS PROGRAM

BAMBERG MILITARY COMMUNITY

GERMANY

Prepared for

DEPARTMENT OF THE ARMY

EUROPE DIVISION, CORPS OF ENGINEERS

FRANKFURT, GERMANY

Prepared by

KELLER & GANNON

Engineers • Architects

1453 Mission Street

San Francisco, California, USA

MAY 1984

CONTRACT NO. DACA90-82-C-0204

SECTION A.0

EXECUTIVE SUMMARY

A.1 INTRODUCTION OF PROJECT

This Executive Summary outlines the results of all work for the Energy Engineering Analysis Program (EEAP), Bamberg Military Community, Germany. This work was authorized under contract number DACA 90-82-C-0204 with the U.S. Army Corps of Engineers, Europe Division, Frankfurt A/M, Germany.

The primary purpose of the Energy Engineering Analysis Program was to develop Energy Conservation Investment Program (ECIP) projects that comply with the objectives set forth in the Army Facilities Energy Plan.

The work was performed in three phases: Phase I consisted of data gathering and inspection of facilities culminating in a data report; Phase II included energy data analysis, evaluation of the technical and economic feasibility of energy conservation opportunities, and completion of the front pages of DD Forms 1391; Phase III included preparation and completion of DD Forms 1391, including detailed justifications and project development brochures (PDB-I's).

The following increments of work were authorized in the scope of services:

- Increment A: Buildings and processes
- Increment B: Utilities and energy distribution systems, Energy Monitoring and Control Systems (EMCS), and use of waste fuels in existing energy plants.
- Increment F: Facilities Engineer funding authority energy conservation projects.

- Increment G: Energy conservation projects found viable but that do not meet ECIP criteria.

A.2 EXISTING ENERGY SITUATION

A.2.1 Baseline FY75 Energy Consumption

Total USMC Bamberg energy consumption by source for FY75 has been reported as follows:[1/]

Electricity		157,667 $\times 10^6$ BTU
Anthracite coal		260,838 $\times 10^6$ BTU
Bituminous coal		49,389 $\times 10^6$ BTU
No. 2 fuel oil		228,163 $\times 10^6$ BTU
Natural gas		14,440 $\times 10^6$ BTU
Liquid propane gas		4,114 $\times 10^6$ BTU
Purchased steam & hot water		5,096 $\times 10^6$ BTU
	TOTAL	719,707 $\times 10^6$ BTU
	Revised Total	786,279 $\times 10^6$ BTU

A.2.2 Present Annual Energy Consumption

Total energy consumption of USMC Bamberg in FY82 of non-transportation energy sources was 990,108 million BTU. A breakdown in FY82 energy consumption and cost by source is shown in the following table:

[1/] Source: Community Facilities Energy Plan, USMC Bamberg. Revised total per 23 March 1982 letter from 7th Corps.

ENERGY SOURCE	QUANTITY	MBTU	AVERAGE COST/MBTU[1/] DOLLARS (DM 2.40=$1)
Natural Gas	303,020 Therms	30,302	10.13
Liquid Propane Gas	48,968 Gallons	4,652	9.27
No. 2 Fuel Oil	1,776,624 Gallons	242,928	7.23
Purchased Steam	6,500 MBTU	6,500	14.22
Coal, Bituminous (Med. Vol)	3,124 Metric Tons	91,366	5.54
Coal, Bituminous (High Vol)	2,561 Metric Tons	73,623	4.10
Coal, Anthracite	10,793 Metric Tons	307,748	6.75
Electricity	20,085 MWH	232,989	6.72

[1/] FY82, 4th quarter

The relative consumption by energy source is shown graphically in Figure A-1.

The breakdown in source energy consumption for FY82 by GY area is shown in Table A-1.

A.2.3 Energy Consumption by End Use and Building Function

The breakdown in source energy consumption by end use is shown in Table A-2. The breakdown in source energy consumption by facility function is shown in Table A-3. The relative consumption by energy use and facility function is shown graphically in Figure A-2.

A.2.4 Typical Building Energy Consumption

A breakdown in estimated FY82 energy consumption by end use (lighting, space heating, domestic hot water heating and process loads) for typical buildings representative of all facilities at USMC Bamberg is shown in Table A-11.

A.3. ENERGY CONSERVATION OPPORTUNITIES DEVELOPED

A.3.1 Energy Conservation Opportunities Investigated

A summary of all potential energy conservation opportunities (ECO's) considered for implementation at USMC Bamberg is presented in Table A-4. A matrix of reasons for eliminating certain ECO's from further consideration is included in Table A-4.

A.3.2 ECIP Projects Developed

During the Phase II effort, documentation was developed for twenty-five ECO's, including many that did not meet the ECIP $200,000 funding minimum. A set of project combinations to attain the ECIP funding minimum were proposed and accepted at the Phase II presentation at USMC Bamberg. The following paragraphs describe these recommended ECIP project combinations.

1. ECIP: Install Heating Plant Inselation, Controls and Waste Heat Recovery includes the following retrofit measures:

   a. Install and repair insulation within heating plants on valves, boilers, vessels, tanks, and piping.

   b. Install continuous boiler blow-down controls with waste heat recovery.

   c. Install hot condensate heat recovery equipment.

   d. Isolate off-line boilers.

   e. Install oxygen trim boiler combustion controls.

2. ECIP: Building Heating Controls Upgrade includes the following retrofit measures:

   a. Install night and weekend temperature setback controls and thermostatic radiation control valves.

   b. Install outside air temperature reset of heating hot water supply.

   c. Provide separate source of make-up air for kitchen exhaust hoods.

3. ECIP: Weatherize MCA Facilities includes the following measures:

   a. Weatherstrip and caulk doors and windows.

   b. Install roof insulation.

   c. Replace single pane windows with dual glazed windows.

4. ECIP: Lighting System Improvements includes the following measures:

   a. Install more efficient lighting fixtures.

   b. Install time control of lighting panels.

A.3.3 Other Energy Conservation Projects Developed

All Increment F projects identified during Phase II--except those that were deleted from the combined projects at the request of USMC Barberg DEH or those Increment F combinations that fall below the $200,000 lower funding limit--have been combined into ECIP projects. No projects identified during this study fall into the Increment G category. Recommended energy conservation projects that fall within the $200,000 funding authority of the Facilities Engineer are summarized in Table A-5.

Complete programming documentation also was prepared for a project to repair leaks and insulation in central heating plant distribution piping that did not meet the minimum level for ECIP funding.

A.3.4 Recommended Policy and Operations Changes

The following policy changes and new policies are recommended for implementation by the military community:

- Laundry Dryer Usage: Laundry dryers in family housing dwellings are electric clothes dryers. A considerable electric demand charge reduction could be realized if these dryers were not used during peak demand periods. It is recommended that a directive be prepared by appropriate authority prohibiting their usage during these periods.
- Barracks Lighting During Non-Occupied Periods: Field investigations for this study indicate that many lights in unoccupied rooms were left on. It is recommended that a directive be prepared by appropriate authority to require that lighting circuits be turned off at panelboards for each section of barracks buildings during schedules times of non-occupancy. (Exceptions should be allowed for personnel that must remain in their rooms for authorized reasons).

The energy conservation policies, plans, and support currently in place at USMC Bamberg are to be commended. Documented energy savings have been realized, and the energy awareness of all community personnel has been heightened.

The following changes in standard operating procedures are recommended for implementation by the military community:

- Turning off Services to Barracks During Field Rotations: It is recommended that all utility services, including lighting, electrical and heating, be turned off in sections of barracks buildings normally occupied by a company that is assigned to field training or BOP service. Personnel left behind for authorized reasons should be temporarily assigned to another room in an (currently) occupied section of the barracks during these periods. (Heating systems should be maintained at a low level of heating during freezing weather to prevent freezing of pipes, etc.)
- Group Relamping: It is recommended that a group relamping program with relamping targeted for 70 percent of rated lamp life be initiated. (See Section 11.0 for details.)
- Boiler Plant Operations: No revisions to present boiler operations are recommended. Considering the age and condition of many boiler plants within the community operations procedures currently in effect provide near-optimal service.

The following suggestion concerns an issue outside the authority of the military community: Coal shipped from the United States comes to Europed with a relatively high content of inert material. The quality of this coal is considerably below that normally available in the United States. The command should consider:

- Revising the specification for this coal, or
- Providing a central cleaning facility at a transshipment point either in the United States or in Europe, or
- Allowing local domestic (foreign) suppliers to submit competitive bids for supplying coal.

A.4 ENERGY AND COST SAVINGS

A.4.1 Energy Consumption Forecast After Total Project Implementation

Monthly energy use profiles for FY82 and projected after implementation of all recommended projects are shown graphically in Figure A-3. Projected energy consumption by end use with conservation measures implemented is summarized in Table A-6. Projected energy consumption by facility function with conservation measures implemented is summarized in Table A-7.

A.4.2 Projected Utility Costs

Projected utility costs for USMC Bamberg are summarized in Table A-8.

A.4.3 Schedule of ECIP Projects

A summary of ECIP project data for USMC Bamberg is provided in Table A-9.

A.5 SUMMARY AND CONCLUSIONS

This EEAP study for USMC Bamberg has provided the following data and deliverables for use by the community in preparing its energy conservation plan and attaining its energy conservation goals:

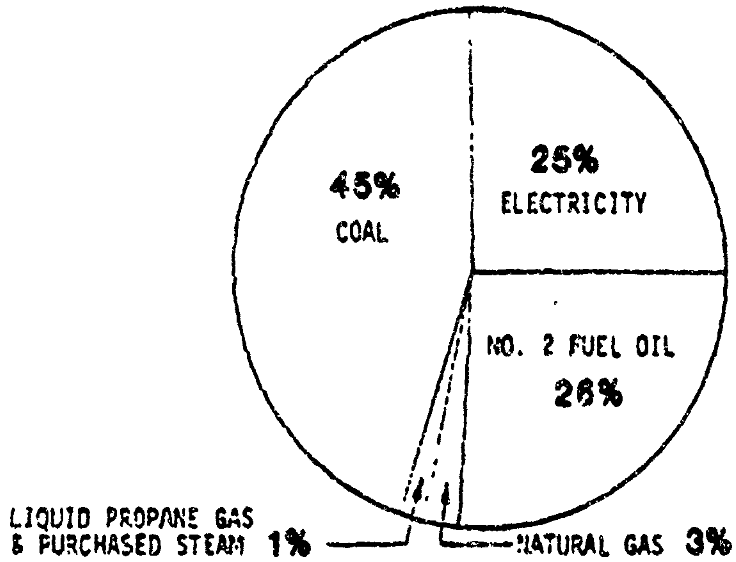
- Historical energy consumption of all USMC Bamberg GY areas.
- Energy consumption by each facility function and end use.
- Energy simulations of 16 typical buildings using the B.L.A.S.T. computer program.

- Documentation for ECO's that should not be accomplished because of insufficient economics.
- Complete DD Forms 1391 and PDB-1's for six ECIP projects and one Increment F project totaling $2,972,200 in construction cost.

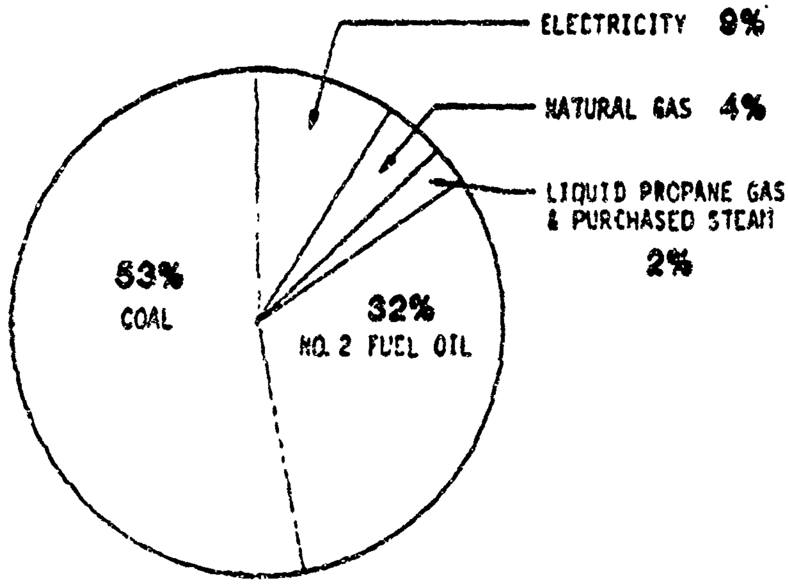
Implementation of all energy conservation projects recommended in this EEAP Study as well as retrofits recently accomplished by the community would result in an overall energy savings of 19 percent[1] from FY75 consumption. (See Table A-10.) This amount marginally meets the savings goal for FY85 of 20 percent.

1/Per square feet of active facilities.

FACILITIES ENERGY CONSUMPTION BY SOURCE
USMC BAMBERG



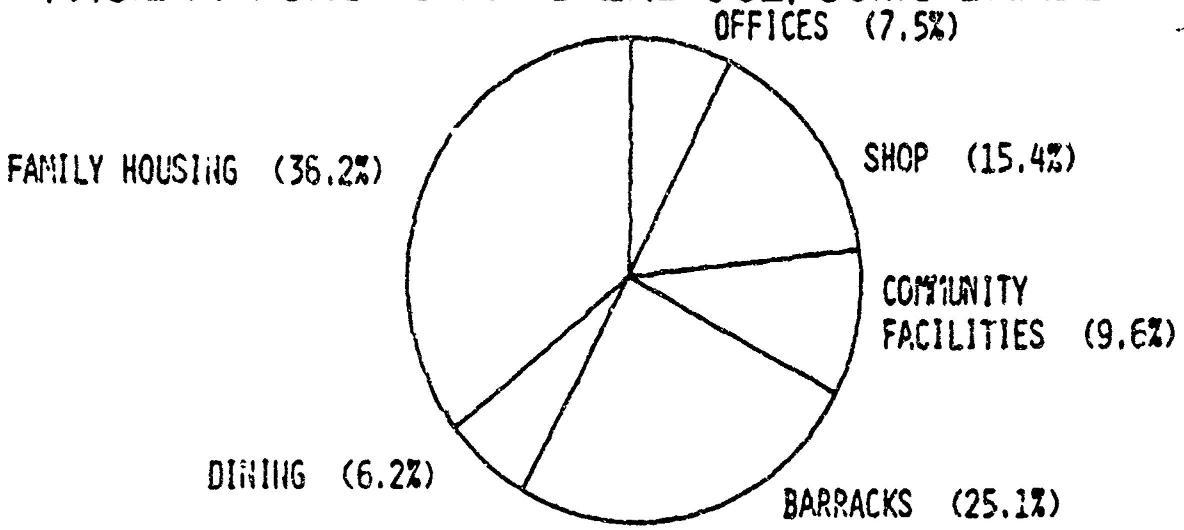
FY 82 FACILITIES ENERGY CONSUMPTION
(ELECTRICITY CONVERTED USING 11,600 BTU/KWH)



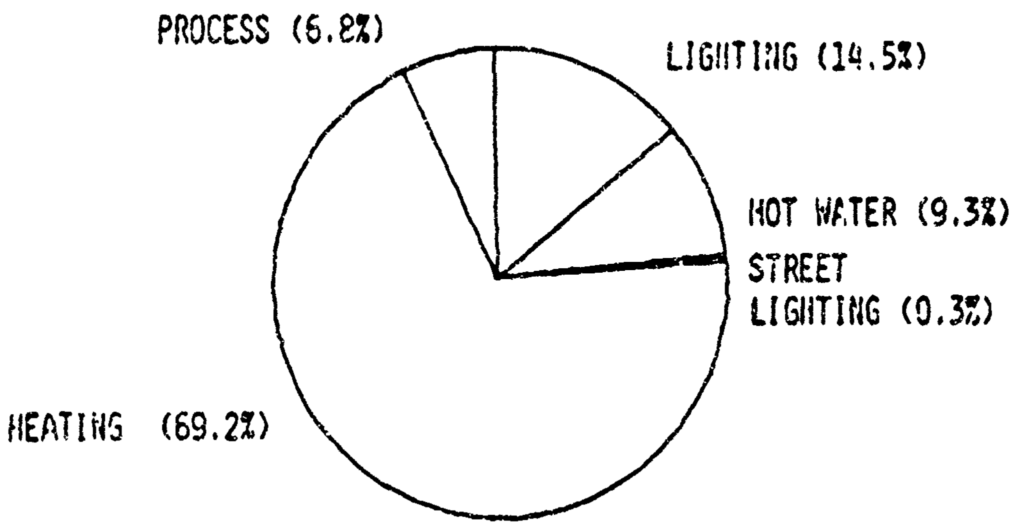
FY 82 FACILITIES ENERGY CONSUMPTION
(ELECTRICITY CONVERTED USING 3,413 BTU/KWH)

FIGURE A-1

FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION AND END-USE, USMC BAMBERG



FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION



FY82 ENERGY CONSUMPTION BY END-USE

FIGURE A-2

SUMMARY: MONTHLY ENERGY USE PROFILES FOR FY82 AND PROJECTED ENERGY CONSUMPTION

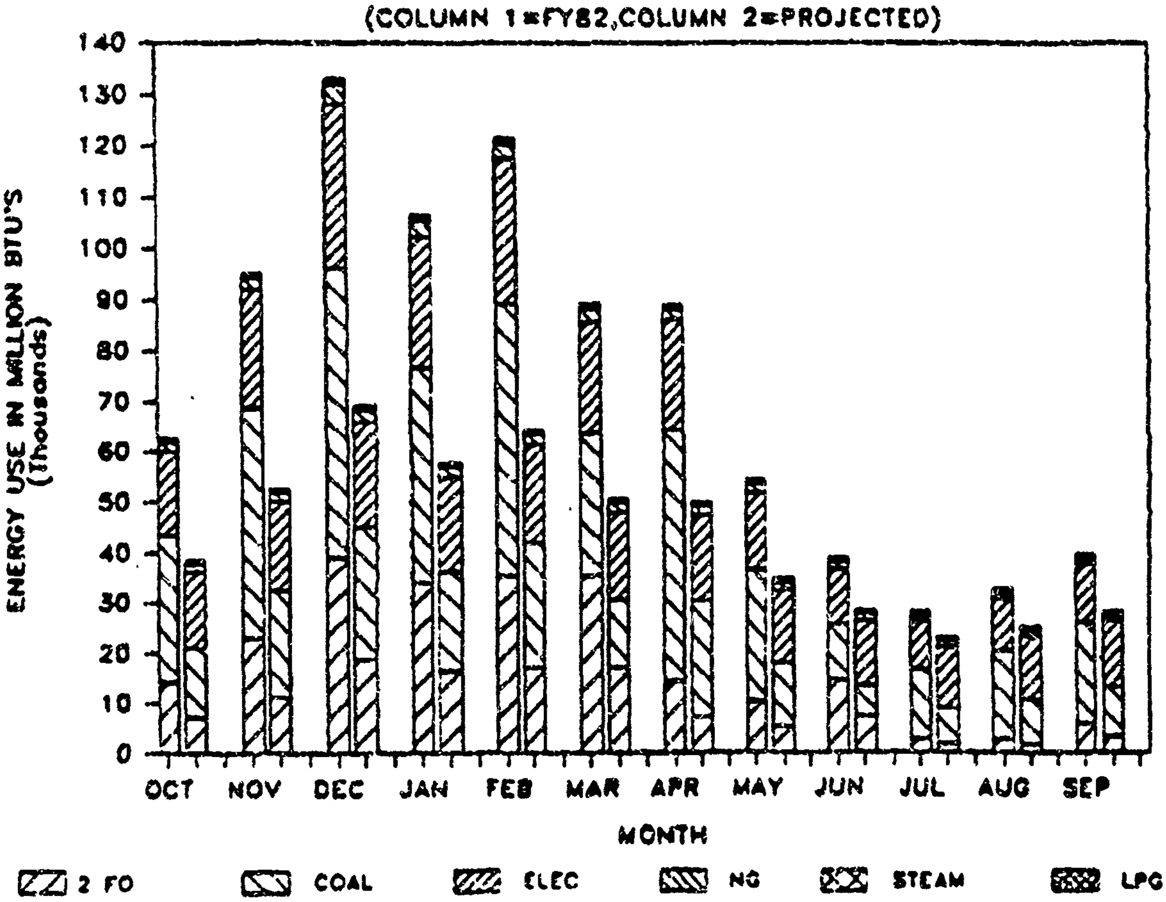


FIGURE 4.3

FY82 ENERGY CONSUMPTION BY GY AREA (10^6 BTU) - USMC BAMBERG

GY AREA/DESCRIPTION	NATURAL GAS 1/	LIQUID PROPANE GAS 2/	NO. 2 FUEL OIL 3/	PURCHASED STEAM	COAL 4/ BITUMINOUS (MED. VOL)	COAL 4/ BITUMINOUS (HI VOL)	COAL 4/ ANTHRACITE	ELECTRICITY 5/	TOTAL ENERGY CONSUMPTION
GY 009: AIRFIELD	-	-	1,726	-	-	-	-	167 7/	1,868
GY 039: AMMO DEPOT ([illegible])	6/	6/	18,526	-	-	-	1,870	12,470 7/	32,866
GY 093: KINGSLEY BARRACKS, HOF	160 7/	-	1,233	6,500 7/	-	-	-	4,600 7/	12,533
GY 150: FLYNN HOUSING AND SCHOOL	10,043		47,087	-	76,609	1,458	14,036	55,682	199,915
GY 175 COBURG/KRONACH HOUSING	35	-	2,006	-	-	-	-	312	2,353
GY 238: PINES HOUSING	6/	-	17,276	-	-	-	12,831	6/	30,107
GY 324: HARRIS BARRACKS, COBURG	363	-	11,140	-	-	-	-	3,093	14,586
GY 685: WARNER BARRACKS I, II, III	14,446	4,652	135,573	-	14,757	2,122	271,856	139,632	583,038
GY 846: [illegible] TAC [illegible] SITE	-	-	1,625	-	-	-	-	11,690	13,315
GY 695: LEASED HOUSING	5,255	-	11,736	-	-	70,043	7,155	5,318	99,507
TOTAL	30,302	4,652	242,928	6,500	91,366	73,623	307,748	232,989	990,108

1/ HEATING VALUE 1.031 x 10^6 BTU/1,000 CU.FT.
2/ HEATING VALUE 95,300 BTU/GALLON.
3/ HEATING VALUE 136,542 BTU/GALLON
4/ ANTHRACITE 28.5 x 10^6 BTU/METRIC TON.
BITUMINOUS (MED. VOLATILE) 29.25 x 10^6 BTU/METRIC TON.
BITUMINOUS (HI VOLATILE) 28.75 x 10^6 BTU/METRIC TON.

5/ SOURCE CONVERSION 11.6 = 10^6 BTU/MWH.
6/ INCLUDED IN CONSUMPTION FOR GY 685.
7/ ESTIMATED, DATA NOT COMPLETE.

SOURCE: USMC BAMBERG DEH RECORDS.

TABLE A-1

SUMMARY OF FY82 ENERGY CONSUMPTION BY END USE: USMC BAMBERG[1/]

ENERGY USAGE CATEGORY	ENERGY USE ESTIMATE FOR FY 82 (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Space Heating	344,285	203,624	8,461	-0-	6,017	54,224	616,612
Domestic Hot Water	48,586	25,626	363	4,652	422	2,902	82,551
Process Consumption	2,668	1,942	16,222	-0-	61	39,463	60,356
Lighting-Inside	-0-	-0-	-0-	-0-	-0-	128,762	128,762
Lighting-Outside / Street	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	395,539	231,192	25,047	4,652	6,500	227,671	890,601

1/ Leased housing is not included.

TABLE A-2

SUMMARY OF FY82 ENERGY CONSUMPTION BY FACILITY FUNCTION: USMC BAMBERG[1/]

BUILDING FUNCTION	ENERGY USE ESTIMATE FOR FY 82 (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Offices and Administration	33,512	14,465	1,795	-0-	-0-	16,732	66,504
Shops and Maintenance	4,794	56,637	4,755	-0-	-0-	10,798	136,985
Barracks and Quarters	105,687	51,956	95	4,652	5,839	54,961	223,190
Community Facilities	46,910	16,137	2,794	-0-	-0-	19,230	85,071
Dining Facilities & Clubs	17,825	20,382	3,247	-0-	661	13,132	55,248
Family Housing	126,810	71,615	12,361	-0-	-0-	110,497	321,283
Utilities - Street Lighting	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	395,539	231,192	25,047	4,652	6,500	227,671	890,601

1/ Leased housing is not included.

TABLE A-3

SUMMARY OF ECO EVALUATIONS FOR USMC HANGERS

DESIGNATION	DESCRIPTION OF ECO	ECIP[1]	INCREMENT "G"	INCREMENT "F"	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
1A	Reduce Equipment Operating Hours							•
2A	Reduce Load Due to Ventilation				•			
3A	Night Set-Back (& Weekends) Thermostatic Controls	•						
3B	Install Dead-Band Thermostats				•			
3C	Install Steam Humidification for Building 7334					•		
4A	Reduce DHW Temperatures			•				
4B	Install Flow Restriction Devices			•				
4C	Install Self-Closing Valves				•			
5A	Isolate Off-Line Boilers	•						
6A	Segregate Areas @ No or Lower Conditioning Levels			•				
7A	Reduce Lighting Levels (Delamp, Relocate)			•				
8A	Reduce Lighting Usage (Photo Cells, Task Switching, Time Clocks)	•						
9A	Use Natural Light (Sky Lights & Clerestory Windows)					•		
10A	Reduce Lamp Wattages			•			•	
10B	Remove/Replace Diffusers and/or Lenses							•
10C	Improve Room Wall & Ceiling Reflectance				•			
10D	Group Relamping Programs						•	
11A	Install More Efficient Lamps						•	
12A	Install More Efficient Lighting Fixtures	•						
13A	Install More Efficient Ballasts					•	•	
14A	Install Wall Insulation					•		
14B	Install New Insulated Maintenance Bay Doors					•		
15A	Install Dual Glazed Windows	•						
16A	Install Roof or Ceiling Insulation	•						

1/ Denotes that ECO is included as part of an ECIP project.

TABLE A-4

SUMMARY OF ECO EVALUATIONS FOR USMC BAMBERG

DESIGNATION	DESCRIPTION OF ECO	ECIP 1/	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
17A	Install Floor Insulation					•		
18A	Caulk and Weather-Strip Ground Doors and Windows	•		•				
18B	Provide Air Curtains on Frequently Used Doors				•			
18C	Install Building Vestibules				•			
19A	Remove (Maintain) Resistances to Air Flow				•			
20A	Reduce Flow Resistance in Liquid Pumping Systems							•
21A	Repair &/or Replace Boiler Plant Piping & Insulation	•						
21B	Insulate Valves in Boiler Plants	•						
21C	Repair, Replace, Install Boiler & Vessel Insulation	•						
22A	Fix Leaks & Insul. in Central Plant Distrib. Systems			•				
23A	Replace Steam Traps							•
24A	Convert Heating Systems to More Efficient Media					•		
25A	Install Thermostatic Radiator Control Valves	•		•				•
26A	Outside Air Temp Resets on HW Heating	•						
26B	Provide Zone Controls for Buildings				•			
27A	Install Economizers on HVAC Systems				•			
28A	Use Separate Make-Up Air for Exhaust Hoods	•						
29A&B	Use Radiant Heating in High Infiltration Areas					•		
30A	Reduce Energy Consumption in Double Duct Systems				•			
31A	Replace Existing with Modular or Auto-Feed Boilers				•			
32A	Reclaim Heat from Flue Gasses to Preheat Comb. Air				•			
33A	Install Flue Gas Economizers (Preheat Feed Water)					•		•
33B	Install Oxygen Trim Boiler Combustion Controls	•						

1/ Denotes that ECO is included as part of an ECIP project.

TABLE A-4

SUMMARY OF ECO EVALUATIONS FOR USMC [illegible]

DESIGNATION	DESCRIPTION OF ECO	ECIP 1/	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
33C	Replace Inefficient with More Efficient Burners					•		
33D	Install Turbulators in Fire-Tube Boilers				•			
33E	Replace Steam with Air-Atomizing Burners					•		
34A	Install Automatic Boiler Blow-Down Controls	•						
34B	Recover Heat from Boiler Blow-Down	•						
35A	Utilization of Heat Reclamation Systems							•
36A	Insulate DHW Distribution Piping within Buildings				•			
37A	Heat Recovery (Hot Gas Exch.) from Laundry Dryers			•				
37B	Hot Drain Exchangers for Laundries & Kitchens			•				
37C	Hot Condensate Heat Recovery (Flash Steam)	•						
38A	Decentralize DHW Service - Non-Heating Season			•				
39A	Solar DHW Heating Systems					•		
40A	Curtail Availability of DHW			•				
41A	Reduce Energy Consumption of Equip. & Machines							•
42A	Reduce Peak (Electrical Loads)							•
43A	Utilize More Efficient Transformers				•			
44A	Replace Oversized Motors						•	
45A	Correct Power Factor			•				
46A	Energy Management & Control System(s) (EMCS)							2/
46B	Power Line Carrier System					•		
47A	Reschedule/Consolidate Utilization of Facilities				•			
48A	Connect to District Heating to Purchase Energy				•			
49A	Install Family Housing Unit Energy Metering						•	

1/ Denotes that ECO is included as part of an ECIP project.

2/ Individual building retrofits recommended rather than EMCS.

TABLE A-1

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC BAMBERG

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10^6 BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT				SIR
					MATERIAL COST	MANHOURS		TOTAL COST (US $)	
						TRADE	HOURS		
REDUCE DHW TEMPERATURES	90 BUILDINGS	1,910	135,763	1,093,304	15,240	MECHANIC	261	22,398	84.24
REDUCE AVAILABILITY OF DHW	14 BUILDINGS	2,730	19,277	768,641	6,678	ELECTRICIAN	122	10,221	26.19
REDUCE DHW TEMPERATURE: FAMILY HOUSING	60 BUILDINGS	381	83,130	1,112,948	47,950	MECHANIC	472	55,909	19.84
REDUCE AVAILABILITY OF DHW: FAMILY HOUSING	38 BUILDINGS	5,474	39,038	457,448	15,392	ELECTRICIAN	280	23,587	19.33
INSTALL FLOW RESTRICTING SHOWER HEADS AND LAVATORY FAUCET INSERTS	102 BUILDINGS	6,940	46,993	648,633	28,457	PLUMBER	759	50,392	12.83
REMOVE UNNECESSARY LIGHT FIXTURES	32 BUILDINGS	3,599	24,185	256,220	-0-	ELECTRICIAN	553	21,316	12.50
REPAIR LEAKS & INSULATING IN CENTRAL PLANT DIST. PIPING	14 CENTRAL HEATING PLANTS	14,374	96,612	1,355,919	44,450	PIPE FITTER	2,502	120,137	11.25
REPLACE BROKEN WINDOW GLASS	23 BUILDINGS	496	143	5,985	374	GLAZIER	23	955	6.20
INSTALL FLOW RESTRICTING SHOWER HEADS & LAVATORY FAUCET INSERTS: FAMILY HOUSING	65 BUILDINGS	3,774	25,708	344,919	33,222	PLUMBER	868	58,301	5.90
FIX LEAKS IN BOILER PLANT PIPING	3 BUILDINGS	42	208	3,976	558	PLUMBER AND PLUMBER'S HELPER	6	834	4.71
INSTALL ROOF INSULATION: FAMILY HOUSING	BUILDINGS 2657, 8390, 8658, 8657	787	5,238	75,491	6,930	CARPENTER	340	17,313	4.35

TABLE A-5

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC BAMBERG

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10^6 BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT				SIR
					MATERIAL COST	MANHOURS		TOTAL COST (US $)	
						TRADE	HOURS		
DECENTRALIZE HW SERVICE DURING NONHEATING SEASON	BUILDINGS 7644, 7645, 7669 IN GT 150	1,213	7,073	121,109	22,134	STEAM FITTER	205	28,094	4.30
LAUNDRY WASHER WASTE HEAT RECOVERY	BUILDINGS 7047 AND 7090 IN GT 605	2,036	14,238	178,658	30,330	PLUMBER	415	42,321	4.21
CAULK AND WEATHERSTRIP DOOR AND WINDOW OPENINGS: FAMILY HOUSING	9 BUILDINGS	1,290	8,502	128,969	16,767	CARPENTER	493	31,053	4.03
LAUNDRY DRYER WASTE HEAT RECOVERY	BUILDINGS 7047 AND 7590 IN GT 625	660	4,698	58,351	15,262	SHEET METAL WORKER	193	20,717	2.81
INSTALL AUTO-CLOSING DEVICES ON EXTERIOR DOORS	18 BUILDINGS	282	1,979	24,716	7,443	CARPENTER	113	10,437	2.37
INSTALL DUAL-GLAZED WINDOWS: FAMILY HOUSING	BUILDING 7703	307	2,585	39,275	6,354	GLAZIER	436	19,650	1.99
INSTALL PHOTO CONTROL CELLS AND FLUORESCENT LAMPS IN EXTERIOR FIXTURES	294 BUILDINGS	3,269	10,456	205,513	38,078	ELECTRICIAN	2,658	118,615	1.73
INSTALL POWER FACTOR CORRECTION CAPACITORS	6 TRANSFORMER STATIONS	0	25,060	235,505	127,404	ELECTRICIAN	1,130	161,934	1.44
REPLACE EXTERIOR LIGHTING FIXTURE WITH PHOTOCELL-CONTROLLED FLUORESCENT FIXTURE	33 BUILDINGS	305	1,742	19,179	11,061	ELECTRICIAN	196	17,800	1.08

TABLE A-5

SUMMARY OF ENERGY CONSUMPTION BY END USE

WITH CONSERVATION PROJECTS IMPLEMENTED: USMC BAMBERG[1/]

ENERGY USAGE CATEGORY	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Space Heating	209,070	127,320	5,070	-0-	3,862	23,930	369,202
Domestic Hot Water	28,470	15,680	300	3,375	424	1,320	49,569
Process Consumption	2,530	1,580	16,222	-0-	61	39,460	59,853
Lighting-Inside	-0-	-0-	-0-	-0-	-0-	119,455	119,455
Lighting-Outside / Street	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	240,020	144,500	21,592	3,375	4,347	186,485	600,399

1/ Leased housing and new facilities are not included. Energy Savings include projects recommended by this EEAP study plus projects completed or programmed by the military community.

TABLE A-8

SUMMARY OF ENERGY CONSUMPTION BY FACILITY FUNCTION
WITH CONSERVATION MEASURES IMPLEMENTED: USMC BAMBERG 1/

BUILDING FUNCTION	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)						
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	TOTAL
Offices and Administration	13,350	9,730	1,060	-0-	-0-	14,528	38,668
Shops and Maintenance	25,140	26,000	2,883	-0-	-0-	8,357	62,380
Barracks and Quarters	98,690	43,165	95	3,375	3,686	48,749	197,760
Community Facilities	35,310	6,825	2,532	-0-	-0-	17,815	62,482
Dining Facilities & Clubs	6,710	11,750	3,247	-0-	661	11,606	33,974
Family Housing	60,820	47,110	11,775	-0-	-0-	83,110	202,815
Utilities - Street Lighting	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	240,020	144,580	21,592	3,375	4,347	186,485	600,399

1/ Leased housing and new facilities are not included. Energy Savings include projects recommended by this EEAP study plus projects completed or programmed by the military community.

TABLE A-7

PROJECTED UTILITY COSTS - USMC BAMBERG

ENERGY SOURCE	AVERAGE COST/MBTU IN DOLLARS (DM 2.40 = $1.00)[1]			
	ACTUAL FY82	PROJECTED FY85	PROJECTED FY90	PROJECTED FY95
Natural Gas	10.13	12.94	13.91	15.80
Liquid Propane Gas	9.27	11.84	12.73	14.46
No. 2 Fuel Oil	7.23	7.79	8.89	12.14
Coal	6.49[2]	7.75	8.46	8.71
Electricity	6.72	7.84	8.20	8.11

ENERGY CONVERSIONS:

- Electricity . . . . 11,600 Btu/kWh
- Anthracite Coal . . . . 28.50×10^6 Btu/metric ton
- Bituminous (Med. Vol) Coal . . . 29.25×10^6 Btu/metric ton
- Bituminous (High Vol) Coal . . . 28.75×10^6 Btu/metric ton
- No. 2 Fuel Oil . . . . 136,582 Btu/gallon
- Natural Gas . . . . 3,413 Btu/kWh (10,760 kWh/m^3)
- Liquid Propane Gas . . . . 95,000 Btu/gallon (4.43 lbs/gallon)

1/ Based on DOE mid-term energy forecasts (commercial sector) for average of U.S. prices, exclusive of general inflation.
2/ Consumption-weighted average of all coal types.

SUMMARY OF ECIP PROJECT DATA FOR USMC BAMBERG

PROJECT TITLE	ENERGY SAVINGS (10^7 BTU/YEAR)	ANNUAL COST SAVINGS (DOLLARS)	TOTAL REQUEST FY 87 ($1,000)	SAVINGS-TO-INVESTMENT RATIO	REFERENCE SECTION (VOL. I)
ECIP: Building Heating Controls Upgrade	71,269	4[illegible],557	881.0	10.18	10.3.2
ECIP: Install Heating Plant Insulation, Controls and Waste Heat Recovery	28,207	185,215	516.0	6.54	10.3.1
ECIP: Weatherize NCA Facilities	35,561	240,824	1,197.1	3.73	10.3.3
ECIP: Lighting Systems Improvements	3,965	30,450	240.3	1.79	10.3.4

TABLE A-9

SUMMARY OF FACILITIES ENERGY CONSUMPTION - USMC BAMBERG 1/

PARAMETER	FY75	FY80	FY81	FY82	FY85
Total Energy Usage (10^6 BTU)	786,279 2/	976,776	951,093	990,108	701,698
Active Facility Area (10^3 SF) 3/	5,209	5,539	5,633	5,673	5,740
Energy Use/SF (10^3 BTU/SF)	150.9	176.3	168.8	174.5	122.2
Percent Increase (Decrease) 4/	--	16.8	11.9	15.7	(19.0)

1/ Includes estimates of energy savings from facility funded projects and those recommended in this document plus planned new construction.

2/ Actual FY75 consumption was 719,707 x 10^6 BTU (including leased housing). Revised figure was provided by VII Corps in letter of 23 March 1982 to account for energy conservation projects implemented before FY75.

3/ Includes leased housing.

4/ Percent increase (decrease) based on FY75 value and usages per square foot.

TABLE A-10

TYPICAL BUILDING ENERGY CONSUMPTION

USMC BAMBERG

FUNCTION	BUILDING NO.	GY AREA	FY 82 ESTIMATED ENERGY CONSUMPTION (MBTU)					GROSS S.F.	KBTU/SF PER YEAR
			LIGHTING	SPACE HEATING	DHW HEATING	PROCESS	TOTAL		
Administration	7088	685	1,182	4,235	43	42	7,077	36,464	194.1
Barracks	7006	685	757	2,191	1,388	175	4,511	23,357	193.1
Motor Repair Shop	7012	685	147	4,040	104	56	4,347	16,490	263.6
Dining	7070	150	1,523	1,595	391	840	4,349	17,478	248.8
Family Housing	7630	150	1,295	3,156	311	507	5,260	31,878	165.0
High School	7543	150	1,514	11,012	347	2,278	15,151	54,978	275.6

An exit interview briefing was held at the completion of the field work. The purpose of the exit briefing was to report progress and to identify energy conservation measures that can be readily implemented by the FE.

Summaries of "Quick Fix" projects for buildings and for heating plants were provided at this time.

6.1.3 Data Base Preparation

The intent of this stage of Phase I work was to summarize all data and information compiled during the field work into a format that facilitates analyses conducted during subsequent phases of work. The data base consists of the following information broken down for each GY Area, where appropriate:

- Energy usage histories, profiles, and source data,
- Building data summaries,
- Buildings excluded from detailed consideration,
- Model, identical and similar building lists,
- Proposed future construction included in the military community Master Plan,
- Utility system data summaries, and
- Meteorological data.

Development of this data base is explained in the following paragraphs.

6.1.3.1 Energy Usage Histories. Energy consumption records made available by the FE include DEH prepared summaries, invoices from suppliers of each source of energy, delivery tickets and receipts. Data was obtained with the highest available degree of disaggregation on both temporal and logistical bases. These data are summarized in Section 4.0 by GY Area, and by building or system where data is available. The associated costs of each energy source are also included and are based on information made available from the military community FE and from the USAREUR Energy Center.

6.1.3.2 Building List Screening and Data Summary. The objective of this stage of Phase I was to provide a tool to focus subsequent engineering efforts on tasks that provide the most meaningful results. The great number of facilities listed on the BIS contain many buildings that consume little or insignificant amounts of energy. Also included are buildings that house only utility systems, warranting separate consideration. The BIS was screened to eliminate these types of buildings. Information relevant to each utility-housing building or system is summarized separately. Buildings with insignificant or no energy consumption are listed in Appendix A. Such facilities will receive little attention in the future as the potential for saving energy in these buildings is limited, at best. Thus, the remaining list of buildings formed the calculation basis for this study. Pertinent information for each of these buildings is summarized in Appendix B and includes information such as heated, window and door areas; heating, cooling and domestic hot water system types and capacities; and building schedule and occupancy.

Potential ECO's were identified for each building, process and utility system during the course of the field work. Potential projects have been broken down into the following categories:

- Operational/Processes
- Lighting Systems
- Building Envelopes
- Utility Distribution Systems
- Heating and Cooling Systems
- Domestic Hot Water Heating Systems
- Electric Power System
- Miscellaneous

The matrix in Appendix E illustrates which ECO's may have potential and be worthy of further investigation for each building. This list summarizes field audit form checklists and is not intended to preclude consideration of additional ECO's. Projects that are already planned or that are under consideration by the Military Community FE are identified.

The ECO's were analyzed in Phase II for each model building. A brief description of each ECO with the planned analysis approach is also presented in Appendix E. ECO's were grouped into ECIP projects as appropriate and an economic analysis was performed.

6.2 PHASE II METHODOLOGY

Phase I data was analyzed, potential energy conservation projects were proposed, potential projects were evaluated by performance of economic and feasibility studies and the first page of DD Forms 1391 were completed for all economically feasible projects. An interim report was submitted at the end of Phase II, including summary, recommendations and conclusions, supporting data, methodology and information sources.

6.2.1 Energy Conservation Opportunities (ECO's)

All ECO's which will provide energy and/or cost reduction if implemented were identified, analyzed and documented. An economic analysis was be performed in accordance with "Energy Conservation Investment Program (ECIP) Guidance" revised 6 August 1982, except that construction cost escalation will comply with Table 4 of AR 415-17. Life cycle cost analysis will be based upon the Savings-to-Investment Ratio (SIR). Those ECO's having a SIR value equal to or greater than 1 will be considered for future project development. Calculations are to be based upon all improvement projects having a construction mid-point at the fourth quarter, FY-1987.

Each model building is to be analyzed in detail by computer modeling and, where necessary, by manual calculations to determine the relative benefit of potential ECO's. Those ECO's appearing practicable will be extended to include the appropriate identical and similar buildings and their investment costs will be estimated.

Building data base information shown in Appendix B will be used in the computer simulation during Phase II to determine the heating and air conditioning loads. It will also be used in Phase II to assist in the evaluation of potential ECO's.

6.2.2 ECIP Projects

All viable ECO's (minimum SIR value of 1.0) were combined into appropriate and logical retrofit projects. SIR values were calculated for the resulting projects. All projects were then to be prioritized (ranked) in descending order starting with the project having the largest SIR value. Also, the first pages of DD Forms 1391 were completed for all viable projects and included in the interim report with supporting data.

For all projects with SIR's greater than 1.0 (ESIR's), the following breakdown applied:

- ECIP: construction cost greater than $200,000.
- Increment F: construction cost less than $200,000 for alteration type work (military community funding authority)
- Increment F: construction cost less than $500,000 for maintenance and repair work (military community funding authority)
- Increment G: projects that exceed the military community's funding approval limits but do not meet all ECIP criteria.

SUMMARY OF ENERGY CONSUMPTION BY END USE

WITH CONSERVATION PROJECTS IMPLEMENTED: USMC BAMBERG[1/]

ENERGY USAGE CATEGORY	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)						TOTAL
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	
Space Heating	209,020	127,320	5,070	-0-	3,862	23,930	369,202
Domestic Hot Water	28,470	15,680	300	3,375	424	1,320	49,569
Process Consumption	2,530	1,580	16,222	-0-	61	39,460	59,853
Lighting-Inside	-0-	-0-	-0-	-0-	-0-	119,455	119,455
Lighting-Outside / Street	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	240,020	144,580	21,592	3,375	4,347	186,485	600,399

1/ Leased housing and new facilities are not included. Energy consumption estimates include the effects of projects recommended by this EEAP study plus projects programmed or recently completed by the military community.

SUMMARY OF ENERGY CONSUMPTION BY FACILITY FUNCTION
WITH CONSERVATION MEASURES IMPLEMENTED: USMC BAMBERG[1/]

BUILDING FUNCTION	ENERGY CONSERVATION ESTIMATE (MILLION BTU PER YEAR)						
	COAL	NO. 2 FUEL OIL	NATURAL GAS	LPG	PURCHASED STEAM	ELECTRICITY	TOTAL
Offices and Administration	13,350	9,730	1,060	-0-	-0-	14,528	38,668
Shops and Maintenance	25,140	26,000	2,883	-0-	-0-	8,357	62,380
Barracks and Quarters	98,690	43,165	95	3,375	3,686	48,749	197,760
Community Facilities	35,310	6,825	2,532	-0-	-0-	17,815	62,482
Dining Facilities & Clubs	6,710	11,750	3,247	-0-	661	11,606	33,974
Family Housing	60,820	47,110	11,775	-0-	-0-	83,110	202,815
Utilities - Street Lighting	-0-	-0-	-0-	-0-	-0-	2,320	2,320
TOTAL ENERGY USAGE FY82	240,020	144,580	21,592	3,375	4,347	186,485	600,399

1/ Leased housing and new facilities are not included. Energy consumption estimates include the effects of projects recommended by the EEAP study plus projects programmed or recently completed by the military community.

The first measure is not cost effective. In order to implement this ECO it would be necessary to provide openings, fans and thermostats in each room. The costs of this type of retrofit are prohibitive.

The latter two methods concern central air handling unit (AHU) installations. As stated for ECO No. 2, very few air handling systems exist in the MILCOM, and those that are installed are fairly new, so the dampers still fit well. Central AHU's have economizer cycles. Several installations of unit heaters, however, currently use 100% outside air. The potential of allowing some return air heating is investigated as ECO No. M27A.

<u>ECO No. 28A: Use Separate Makeup Air for Exhaust Hoods</u>

See Section 10.3.

<u>ECO No. 29A: Install Radiant Heating in High Infiltration Areas</u>

Evaluation of a project to install gas-fired radiant heaters in maintenance buildings yielded an SIR less than 1.0.

<u>ECO No. 29B: Install Steam/Hot Water Radiant Heating Panels</u>

Evaluation of a project to install ceiling-mounted steam or hot water radiant heating panels in shop buildings yielded a SIR less than 1.0.

<u>ECO No. 30A: Reduce Energy Consumed in Double Duct Systems</u>

No double duct systems serve buildings in the military community.

ECO No. 31A: Replace Existing Boilers with Modular or Automatic Feed Boilers

Central heating plants in the community are comprised of modular boiler installations where such installations are appropriate for load fluctuations.

There are no manual feed boilers at USMC Bamberg.

ECO No. 32A: Reclaim Heat from Flue Gases to Preheat Combustion Air

Only heating plant with economic application of this ECO (Building 7667) is programmed for a consolidation project.

ECO No. 33A: Install Flue Gas Economizers (Preheat Feed Water)

This project is mutually exclusive with ECO No. M32A, Installation of Air Preheaters. Economic evaluation of this project yielded an SIR less than 1.0.

ECO No. 33B: Install Oxygen Trim Boiler Combustion Controls

See Section 10.3.

ECO No. 33C: Replace Inefficient Burners with More Efficient Units and ECO No. 33E: Replace Steam Atomizing with Air Atomizing Burners

This ECO is devoted primarily to No. 2 oil fired boilers. The vast majority of these boilers have been refilled with new burner assemblies within recent years. Combustion efficiency tests conducted for this project indicate relatively efficient combustion. Other retrofits, including installation of oxygen trim controls, will improve performance to near optimum levels, leaving little room for improvement.

Replacing burners on the relatively small boilers within the MILCOM would be quite costly. Little additional fuel savings could be expected and could not justify the level of investment required.

An additional consideration is the possibility that these boilers may soon need to be changed over to coal firing.

This ECO has been eliminated from further consideration for these reasons.

ECO No. 33D: Install Turbulators in Fire Tube Boilers

According to conversations with Facilities Engineering personnel during the course of field investigations, there are no fire tube boilers in use at MILCOM facilities. Thus, this ECO does not apply.

ECO No. 34A: Install Automatic Boiler Blow-Down Controls and ECO No. 34B: Recover Heat from Boiler Blow-Down

See Section 10.3 for description of a project that implements both ECO's.

ECO No. 35A: Utilization of Heat Reclamation Systems

Most of the ECO's listed under this category are addressed under other ECO's. Thermal wheels are analyzed in ECO No. 37 for laundry dryers.

It is felt that thermal wheels (heat pipes and run-around) cannot be economically applied to the very few HVAC systems within the MILCOM.

10.1.6 Domestic Water Heating System ECO's

ECO No. 36A: Insulate Domestic Hot Water (DHW) Storage Tanks and Piping

Insulation of vessels is addressed under ECO No. 21. This ECO number is used exclusively for distribution piping insulation within buildings.

Even though the calculated SIR for insulating domestic hot water piping in Building 7005 is above 1.0 (SIR = 1.07), the value will fall below 1.0 upon implementation of ECO No. 40A, Timer Control of DHW Circulation Pumps. Therefore, this ECO is not recommended for implementation.

ECO No. 37A: Heat Recovery from Laundry Dryers

See Section 11.2.

ECO No. 37B: Hot Drain Exchangers for Laundries and Kitchens

See Section 11.2.

ECO No. 37C: Hot Condensate Heat Recovery (Flash Steam)

See Section 11.2.

ECO No. 38A: Decentralize DHW Service During Nonheating Season

The only central heating plant that yielded an SIR greater than 1.0 for decentralization of DHW service was Building 7667. See Section 11.2 for description of a project to install several small boilers in GY 150 for operation during the nonheating season.

ECO No. 39A: Solar DHW Heating Systems

This project would install roof collectors, piping and controls to provide solar assisted heating for domestic hot water used in barracks. Existing storage tanks would be used and existing heat exchangers, heaters, etc., would be retained as supplemental backup systems. Energy is saved because solar radiation is used to provide DHW heating rather than a purchased energy source.

Based on a sample analysis for a 200-man barracks, the project yields an SIR less than 1.0 due to the high cost of implementation.

ECO No. 40A: Curtail Availability of Domestic Hot Water

See Section 11.2.

10.1.7 Power Systems ECO's

ECO No. 41A: Reduce Energy Consumption of Equipment and Machines

This ECO cuts across several categories and, therefore, is addressed separately in the following ECO's:

ECO No. 3A: Time Switches for Heating Systems

ECO No. 8A: Time Switches for Lighting Systems

ECO No. 40A: Time Switches for Domestic Hot Water Systems

ECO No. 46A: Energy Monitoring and Control Systems

ECO No. 46B: Power Line Carrier Control System

ECO No. 42A: Reduce Peak Electrical Loads

This generic ECO is analyzed under the following two specific projects: ECO No. 46A, EMCS and ECO No. 46B, Power Line Carrier Control System.

ECO No. 43A: Utilize Efficient Transformers

This ECO involves replacing existing dry-type transformers with units having lower heat-rise ratings, since efficiency increases as temperature-rise rating decreases.

This ECO finds little application at USMC Bamberg, since the base distribution is 380/220V from utility-owned 20kV-380/220V transformers.

Small 220V-110V, single phase stepdown transformers are found throughout the MILCOM (several kVA each). Efficiency gains in such small units would result in insignificant savings.

As replacement becomes necessary, however, low temperature-rise transformers should be used, as the incremental cost of the efficient transformer should be justified by energy savings.

ECO No. 44A: Replace Oversized or Inefficient Motors

No motors in the MILCOM inventory of heating and cooling equipment were identified as being sufficiently oversized to warrant replacement.

An incremental analysis of replacing failed motors with energy-efficient units is provided in Section 11.3.

ECO No. 45A: Correct the Power Factor

See Section 11.2.

ECO No. 46A: Install an Energy Monitoring and Control System

See Section 9.0 for a summary of the feasibility study for an EMCS application at USMC Bamberg.

ECO NO. 46B: Install a Power Line Carrier System

Consideration of a power line carrier system for duty cycling and demand limiting of electrical loads resulted in an uneconomic project.

10.1.8 Miscellaneous ECO's

ECO No. 47A: Reschedule/Consolidate Utilization of Facilities

There appear to be no applications of this ECO for the facility. The MILCOM is presently using every space available. Considerable effort has been expended by the command to utilize the limited available resources as effectively as possible. However, expansion facilities that are funded and/or planned should ease the situation in the future.

ECO No. 48A: Connect to District Heating to Purchase Energy

District heating plants for Bamberg are operated by Zweckverband Muellverbrennung. The company's locations and distribution systems are not located within economic piping distances of U.S. Army facilities in Bamberg. Current capacity is rated adequate only for customers' needs through 1995, and there are no plans to extend service to locations near USMC Bamberg facilities.

Reference:

Zweckverband Muelluerbrennung

Rheinstrasse 6

8600 Bamberg

Attention: Mr. Reimann

ECO No. 49A: Install Family Housing Unit Energy Metering

Although metering of electrical consumption of each family housing unit will not, of itself, reduce energy consumption, metering data might be used by family housing management and DEH personnel to generate energy reductions. Relative ranking of each household together with comparative data from previous years could be disseminated to motivate further energy reductions.

10.2 ECIP ANALYSIS ASSUMPTIONS

10.2.1 Economic Assumptions

Economic analyses based on present worth techniques were performed for all potential ECIP projects and sub-projects using the economic analysis form and procedures outlined in "Energy Conservation Investment Program (ECIP) Guidance" revised 18 February 1983. The following assumptions and methods were used to develop standard input for economic analyses of all projects:

1. Investment costs include the following: construction costs; estimating contingency at 5% of construction costs; supervision, inspection and overhead (SIOH) at 5.5% of construction costs; and design at 6% of construction costs. To compute total investment, the sum of the above costs was reduced by 10% to allow for energy credits.
2. The ECIP economic analysis was performed based on current (second quarter FY83) cost. Construction cost growth shown on DD Forms 1391 was computed using a general inflation factor from 1 January 1983 to 1 July 1987 of 5% per year, or 25.55% total.
3. Mid-point of construction was assumed to be the fourth quarter of FY87, or 1 July 1987.
4. The present value of recurring energy benefits was obtained by using the U.S. average "modified" uniform present worth discount factors as contained in the ECIP Guidance. These factors are based on a 7% discount rate and include DOE projected escalation rates for energy prices developed from the mid-term energy forecasting system.
5. The present value of recurring non-energy benefits was obtained assuming a 0% differential inflation rate and a 7% discount rate, as specified in the ECIP Guidance.

10.2.2 Energy Cost Assumptions

Unit energy costs used in computing the dollar value of energy savings were the average costs actually billed during the fourth quarter of FY82 as shown in Table 10-2.

For electricity demand reduction, the following billing rates, charged during the fourth quarter of FY82, were used:

Location of Demand Metering	Rate (Dollars/KVA)
Family Housing	6.17
Central Heating Plant	6.17
Health and Dental Clinic	6.17
Warner Barracks	8.75
MUNA	8.75

10.3 INCREMENTS A AND B ECIP PROJECTS

The following paragraphs describe all Increment A and Increment B projects that meet ECIP criteria as outlined in the revised ECIP guidance dated 18 February 1983. These ECIP projects consist of combinations of retrofit measures presented to, and accepted by, USMC Bamberg DEH personnel at the Phase II presentation on 18 October 1983. Backup energy analysis and cost data for each project are included in Appendix J.

10.3.1 ECIP: Heating Plant Insulation, Controls, and Waste Heat Recovery

10.3.1.1 Install and/or Repair Insulation in Heating Plants (ECO No. H21A, B, C)

This project proposes to install and/or repair insulation within heating plants on valves, boilers, vessels, tanks and piping.

1. Valve Insulation: Insulating valves within boiler plant boundaries will reduce heat losses within the plant, and thus improve the heating plant thermal efficiency. Improved efficiency will save heating energy.

2. Boiler, Vessel and Tank Insulation: Boiler insulation is deteriorated and settling in a number of older boilers in the MILCOM. Condensate receivers and other vessels are, in several instances, not insulated or are in need of repairs. Boiler casing insulation and vessels containing hot water should be well insulated to ensure higher heating plant efficiencies. It is proposed to repair boiler casing insulation, and insulation on other vessels in need of repair. It is also proposed to install new insulation on vessels that do not have it now.

3. Piping Insulation: It is proposed to repair and/or to replace piping insulation in heating plants. Present heat losses from piping can be reduced by providing more effective insulation. A reduction in heat losses will increase plant efficiency and, thus, save heating fuels.

10.3.1.2 Install Boiler Heat Recovery Systems (ECO Nos. M32A, M34A, M34B)

This project addresses one method of recovering "waste" heat from facility heating plant boilers: installation of boiler blow-down controls with heat recovery.

This project is proposed for heating plants in Buildings 7043, 7048, 7032 and 7493. The existing blow-down procedure in heating plants consists of draining blow-down directly into the sewer once or twice a day. It is recommended that valves be installed for continuous blow-down and that a heat exchanger be installed to reclaim the wasted heat. The heat exchanger will be used to preheat makeup water, thus reducing the amount of heating energy needed. A new, adjustable, manually set valve will be installed for a continuous surface blow-down. A new blow-down header will be installed to collect blow-down from each operating boiler.

10.3.1.3 Install Hot Condensate Heat Recovery Equipment (ECO NO. M37C)

Condensate returns to receiver tanks are vented to the atmosphere. Recovery of lost steam and its heat can be accomplished by installing a small condenser on the vent line. Makeup water can be preheated by this equipment.

10.3.1.4 Isolate Off-Line Boilers (ECO No. M5A)

Low heating loads on central plants that have several boilers are often satisfied by a single boiler with several other boilers idling or on standby to accommodate peak demands. These idling boilers use energy to meet standby losses. Induced flow of air through these boilers due to stack effects can further aggravate this problem.

Boilers that are not due to be brought on-line imminently to meet scheduled demand increases can be secured and isolated from boilers that are operating. Isolation can be achieved by closing valves and dampers. Larger boilers can be fitted with orifices to provide the minimum air flow through the boiler required to keep it warm, avoiding thermal stress when it is brough on-line again. Bypass valves installed on boiler returns will also reduce losses.

10.3.1.5 Install Oxygen Trim Boiler Combustion Controls (ECO No. M33B)

This project will install oxygen trim controls on boilers in the MILCON. These controls save energy by improving control of the combustion process. Higher combustion efficiency is achieved by limiting the amount of excess air to optimum levels. Savings range from about 1.5% to 3.0% of fuel use depending on load conditions.

10.3.2 ECIP: Building Heating Controls Upgrade

10.3.2.1 Install Night/Weekend Setback of Temperature Requirements (ECO No. M3A and M25A)

This project will implement night and weekend setback of building steam supply or hot water temperature. Steam capacities will be controlled by replacing the existing control valve with two automatic control valves piped in parallel and sized for one-third and two-thirds of the total load, with the smaller valve used during setback times. Hot water temperature setback will be accomplished by replacing the existing control valve with a three-way diverting valve to provide lower temperature water during the setback hours.

For all radiators in each controlled building not already equipped, thermostatic control valves will be installed to ensure proper warm temperatures.

10.3.2.2 Install Outside Air Temperature Reset on Hot Water Heating (ECO No. M26A)

This project will modify heating system controls for buildings heated with hot water (HW). New controls will provide temperature resets based on outside air (OS) temperature. Adjust HW circulation temperatures from present 90°C/60°C (194°F/140°F) to 70°C/40°C (160°F/106°F) for periods when OS tempearture is above 40°F.

Energy is saved in HW distribution piping due to a lower temperature difference (T) between the air and the piping, thus lowering distribution losses. Energy savings are also effected in heating plant boilers due to increased thermal efficiencies resulting from higher T's between combustion gases and liquids inside boiler tubing.

For HW central plans, install controls on the HW supply side to adjust supply temperature to 160°F whenever OS temperature rises above 40°F.

10.3.2.3 Provide Separate Makeup Air for Exhaust Hoods (ECO No. M29A)

A number of buildings have kitchens with exhaust hoods that exhaust air directly from the kitchen. By supplying a separate source of makeup air at each location, considerable savings can be made because of not having to exhaust heated kitchen air.

The makeup air will consist of outside air passed through a heating coil so as to avoid freezing problems. Each heating coil will be supplied with either steam or hot water depending on what is available in the building. The outside air can be obtained in one of two ways. The first would employ a ceiling-mounted fan-coil unit, and the second a roof-mounted heating coil. Choice of method will depend on the construction of the building in the area of the fan-coil installation.

10.3.3 ECIP: Weatherize MCA Facilities

10.3.3.1 Weatherstrip Doors and Windows (ECO No. 18A)

This project will reduce infiltration of outside air through doors and windows by providing weatherstripping and caulking where necessary. Buildings already renovated or funded for renovations have been removed from this project.

10.3.3.2 Install Roof Insulation (ECO No. A16A)

This project will provide roof or ceiling insulation in buildings not already insulated. This measure will greatly reduce the winter heating loads by increasing the thermal resistance of roofs.

Two types of isulating material will be applied, depending on building construction: (1) polyurethane hard-foam for single story maintenance buildings with concrete slab roofs, or (2) foil-backed mineral fiber for buildings with attic spaces.

10.3.3.3 Install Dual Glazed Windows (ECO No. A15A)

This project would install new thermopane windows to replace existing wood frame single pane windows. The increased thermal resistance of dual glazing will reduce heat loss through windows. Only buildings not already retrofitted with thermopane windows or included in a funded project for such work are included in this project.

10.3.4 ECIP: Lighting System Improvements

10.3.4.1 Install More Efficient Lighting Fixtures (ECO No. E12A)

This project will replace inefficient incandescent lighting fixtures with more efficient fluorescent fixtures.

The following retrofit actions would be implemented by this project:

1. Replace 60-150 watt incandescent fixtures with 34 watt energy saving fluorescent fixtures.

10.3.4.2 Install Time Switch Control of Lighting Panels (ECO No. E8A)

This project will install time switch control of lighting panels in buildings having a maximum two-shift occupancy.

Time switches would be set to turn off lighting at end of occupied periods and turn on lighting prior to start of a shift. Override switches will be provided at each panel to be activated in the event of a temporary change in building usage.

10.4 Increment G Projects

All combined projects having an investment cost greater than $200,000 (escalated to FY87) met ECIP criteria. Those projects (and project combinations) having an investment cost less than $200,000 fall within the military community's funding authority and management control and are considered, therefore, under Increment F. Accordingly, no Increment G projects were developed.

ECO No. 22A: Repair Leaks and Insulation in Central Plant Distribution Systems

See Section 11.2.

ECO No. 23A: Replace Steam Traps

Replacement of steam traps is evaluated together with thermostatic radiator control valve retrofit, ECO No. 25A.

ECO No. 24A: Convert Heating Systems to More Efficient Media

To convert an existing system to another heat transfer medium would involve major repiping in all cases, along with replacement of terminal heating units, boilers, pumps and controls. Therefore, the cost of conversion would far exceed any savings due to reduced pumping requirements or less maintenance. See Appendix M for a summary of the advantages and disadvantages of each heat transfer medium.

10.1.5 HVAC Equipment ECO's

ECO No. 25A: Install Thermostatic Radiator Control Valves

Thermostatic radiator control valves will be installed as part of a project to implement night/weekend temperature setback (ECO No. M3A). See Section 10.3.

SUMMARY OF ECO EVALUATIONS FOR USMC BAMBERG

DESIGNATION	DESCRIPTION OF ECO	ECIP 1/	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
13A	Install Floor Insulation					•		
15A	Caulk and Weather-Strip Around Doors and Windows	•		•				
15B	Provide Air Curtains on Frequently Used Doors				•			
15C	Install Building Vestibules				•			
19A	Reduce (Maintain) Resistances to Air Flow				•			
20A	Reduce Flow Resistance in Liquid Pumping Systems							•
21A	Repair &/or Replace Boiler Plant Piping & Insulation	•						
21B	Insulate Valves in Boiler Plants	•						
21C	Repair, Replace, Install Boiler & Vessel Insulation	•						
22A	Fix Leaks & Insul. in Central Plant Distrib. Systems	•						
23A	Replace Steam Traps							•
24A	Convert Heating Systems to More Efficient Media					•		
25A	Install Thermostatic Radiator Control Valves	•		•				•
26A	Outside Air Temp Resets on HW Heating	•						
26B	Provide Zone Controls for Buildings				•			
27A	Install Economizers on AHU Systems				•			
28A	Use Separate Make-Up Air for Exhaust Hoods	•						
29A&B	Use Radiant Heating in High Infiltration Areas					•		
30A	Reduce Energy Consumption in Double Duct Systems				•			
31A	Replace Existing with Modular or Auto-Feed Boilers				•			
32A	Reclaim Heat from Flue Gasses to Preheat Comb. Air				•			
33A	Install Flue Gas Economizers (Preheat Feed Water)					•		•
33B	Install Oxygen Trim Boiler Combustion Controls	•						

1/ Denotes that ECO is included as part of an ECIP project.

TABLE 10-1

SUMMARY OF ECO EVALUATIONS FOR USMC BAMBERG

DESIGNATION	DESCRIPTION OF ECO	ECIP 1/	INCREMENT 'G'	INCREMENT 'F'	NOT APPLICABLE	SIR LESS THAN 1.0	IN-HOUSE MAINTENANCE EFFORT	INCLUDED UNDER OTHER ECO'S
33C	Replace Inefficient with More Efficient Burners					•		
33D	Install Turbulators in Fire-Tube Boilers				•			
33E	Replace Steam with Air-Atomizing Burners					•		
34A	Install Automatic Boiler Blow-Down Controls	•						
34B	Recover Heat from Boiler Blow-Down	•						
35A	Utilization of Heat Reclamation Systems							•
36A	Insulate DHW Distribution Piping within Buildings				•			
37A	Heat Recovery (Hot Gas Exch.) from Laundry Dryers			•				
37B	Hot Drain Exchangers for Laundries & Kitchens			•				
37C	Hot Condensate ~~Heat Recovery~~ (Flash Steam)	•						
38A	Decentralize DHW Service - Non-Heating Season			•				
39A	Solar DHW Heating Systems					•		
40A	Curtail Availability of DHW			•				
41A	Reduce Energy Consumption of Equip. & Machines							•
42A	Reduce Peak (Electrical Loads)							•
43A	Utilize More Efficient Transformers				•			
44A	Replace Oversized Motors						•	
45A	Correct Power Factor							
46A	Energy Management & Control System(s) (EMCS)							2/
46B	Power Line Carrier System					•		
47A	Reschedule/Consolidate Utilization of Facilities				•			
49A	Connect to District Heating to Purchase Energy				•			
49A	Install Family Housing Unit Energy Metering						•	

1/ Denotes that ECO is included as part of an ECIP project.

2/ Local building retrofits recommended rather than a community-wide EMCS due to significantly greater SIR.

TABLE 10-1

with hot water/cold water thermostatically controlled mixing valves to avoid central plant operating problems.

11.2.2 Install Flow Restriction Devices (ECO No. M4B)

This project will reduce domestic hot water consumption by reducing flow rates in faucets and shower heads. When hot water consumption is reduced, the amount of energy used to heat the water is reduced.

Present flow rates are 3 gallons per minute (GPM) for faucets and 5 GPM for shower heads. New faucet inserts and shower heads will be installed at flow rates of 0.75 GPM for faucets and 3 GPM for shower heads.

11.2.3 Install More Efficient Lighting Fixtures (ECO No. E12A)

This project will replace existing incandescent, manually-switched entrance lighting fixtures with 18-watt fluorescent, photocell-controlled fixtures. Energy savings results from reduced lighting demand and reduced hours of operation.

11.2.4 Repair Leaks and Insulation in Central Plant Distribution System (ECO No. M22A)

This project involves renovating distribution piping systems from central plants. The evaluation considers replacing insulation as needed and fixing leaking pipes. Energy savings will be effected by reducing heat loss through insulation in poor condition and through leaking pipes. Most of the renovation work will be accomplished by workers inside the pipe channels. However, the channels will be excavated where necessary.

11.2.5 Provide Heat Recovery from Laundry Dryers (ECO No. M37A)

This project is proposed for commercial size "Coin-Op" laundry dryers located in the MILCOM. These dryers exhaust air used to dry the clothes directly outside. It is proposed to install an air-to-air heat exchanger between the hot exhaust air leaving the dryer and the cold air entering the dryer. This will preheat the incoming air, reducing the amount of heating energy needed.

The heat exchanger itself will be of the rotary wheel type. Each dryer will have its own heat exchanger and operate independently of others. With individual systems maximum efficiency is obtained.

It is also recommended that a lint filter be fitted in-line with the exhaust before hot air is passed through the heat exchanger. This will minimize clogging and washdown intervals.

11.2.6 Install Hot Drain Exchanger for Laundries and Kitchens (ECO No. M37B)

This project is proposed for commercial sized "Coin-Op" laundry washers located in the MILCOM. These washers drain hot water, used to wash clothes, directly into the sewer. It is proposed to install a heat reclamation system that will reclaim the wasted heat from the drain water. Recovered heat will be used to preheat cold water going into washers. Preheating will reduce the amount of heating energy needed. Preheated fresh water then flows through another water heater where it is brought up to desired operating temperature and discharged to a storage tank for use upon demand.

11.2.7 Decentralize Domestic Hot Water Service During Nonheating Season (ECO No. M38A)

The central heating plant located in Building 7667 provides steam for heating and domestic hot water (DHW) to buildings in GY 685 and GY 150. Three of the buildings served in GY 150 are provided with steam which is used in heat exchangers to generate DHW. Thus, during the summer, when space heating is not required, steam must still be delivered to these buildings.

This project will install small boilers at each of the service points dedicated for operation during the nonheating season. The new boilers will be tied into existing DHW generating equipment in order to take the place of steam supplied from the central plant.

Energy savings will be generated in two ways. First, distribution piping losses from central plants will be eliminated during the nonheating season. Second, the thermal efficiencies of new domestic hot water installations will be higher than those in the central plant.

11.2.8 Curtail Availability of Domestic Hot Water (ECO No. M40A)

Domestic hot water is circulated continuously through piping distribution and return systems in many buildings. This feature provides hot water at the tap without a long waiting period. However, when demand is at its lowest, continuous circulation allows energy to be wasted through thermal losses in the distribution and return piping. This project will stop circulation when demand is at its lowest, and when instantaneous hot water is not needed. Energy savings will be generated by installing a seven-day calendar time-switch on circulation pump power supplies. Pumps will be turned off seven hours a day.

11.2.9 Install Power Factor Correction Capacitors (ECO No. E45A)

USMC Bamberg facilities located in Bamberg are billed monthly for kVA demand. By application of power factor correction capacitors at each demand metering station, kVAR demand may be reduced. This kVAR reduction translates into kVA demand savings and reduced monthly bills.

Out of eleven (11) transformer stations with demand metering at USMC Bamberg, ten (10) will benefit from installation of capacitors on the secondary 380-volt bus to increase the power factor to .98.

11.3 ELECTRIC MOTOR REPLACEMENT

Analysis of electric motor replacement upon burnout with high efficiency units was performed, where energy cost savings must justify the incremental expense of an energy-saving motor versus a standard motor. Group replacement of operating motors was not considered since the energy savings realistically would not cover the total cost for removing an existing unit and installing an energy-efficient motor.

Results of the analysis, as presented in Table 11-2, indicate a one and one-half to four-year simple payback period for motors 3 HP and above (based on $0.07 per kWh electricity and 2,520 hours of operation per year).

11.4 GROUP RELAMPING OF LIGHTING FIXTURES

Comparison of the annual cost of group relamping versus spot relamping of standard 40-watt fluorescent lamps is presented in Table 11-3. As shown, group relamping results in approximately a 40 percent reduction in relamping costs. However, when the total costs of operation are considered, the savings only amount to 5 percent.

A graph of the percentage of fluorescent lamps operating versus percent rated average life and percent burnouts (shown in Figure 11-1) indicates that group relamping should be performed between 50 and 80 percent of rated average life. Rated average life versus burning cycle (hours per start) is shown in Figure 11-2. Figure 11-3, graph of total cost versus relamping period, indicates an optimal relamping period of 70 percent of average life. Figure 11-4 shows the effect on light output over time of various factors, including temperature and voltage, dirt on worn surfaces, lamp lumen depreciation, lamp outages not replaced, and dirt on luminaires.

11.5 ENERGY LIBRARY

The following texts and references have been found useful in energy conservation work conducted by Keller & Gannon. This listing is not a complete bibliography of references used in this effort, but it does list those that are considered most useful.

- ASHRAE HANDBOOKS: American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., New York, New York:
  -Fundamentals Volume
  -Applications Volume
  -Systems Volume
  -Equipment Volume
- "Architects' and Engineers' Guide to Energy Conservation in Existing Buildings," U.S. Department of Energy, Federal Energy Management Program, 1 February 1980; DOE/CS-0132-115029.
- Thumann, Albert, P.E., "Handbook of Energy Audits," The Fairmont Press, Inc., Atlanta, Georgia, 1979.

- Roose, R.W., P.E., "Handbook of Energy Conservation for Mechanical Systems in Buildings," Van Nostrand Reinhold Co., 1978.
- Hicks, T.G., P.E., "Standard Handbook of Engineering Calculations," McGraw-Hill Book Company, 1972.
- "Steam/Its Generation and Use," Babcock & Wilcox, New York, New York, 1979.

Other useful references include standard engineering handbooks for mechanical, civil and electrical engineering disciplines.

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC BAMBERG

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10^6 BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT				SIR
					MATERIAL COST	MANHOURS		TOTAL COST (US $)	
						TRADE	HOURS		
REDUCE DHW TEMPERATURES	98 BUILDINGS	1,918	135,763	1,893,384	15,240	MECHANIC	261	22,398	84.24
REDUCE AVAILABILITY OF DHW	14 BUILDINGS	2,730	19,277	268,641	6,670	ELECTRICIAN	122	10,221	26.19
REDUCE DHW TEMPERATURE: FAMILY HOUSING	68 BUILDINGS	381	83,134	1,112,948	42,950	MECHANIC	472	55,909	19.84
REDUCE AVAILABILITY OF DHW: FAMILY HOUSING	30 BUILDINGS	5,474	39,030	457,440	15,392	ELECTRICIAN	280	23,587	19.33
INSTALL FLOW RESTRICTING SHOWER HEADS AND LAVATORY FAUCET INSERTS	102 BUILDINGS	6,900	46,503	648,633	28,457	PLUMBER	759	50,392	12.83
REMOVE UNNECESSARY LIGHT FIXTURES	32 BUILDINGS	3,590	24,185	266,220	-0-	ELECTRICIAN	553	21,316	12.50
REPAIR LEAKS & INSULATION IN CENTRAL PLANT DIST. PIPING	14 CENTRAL HEATING PLANTS	14,374	96,612	1,355,919	44,450	PIPE FITTER	2,502	120,137	11.25
REPLACE BROKEN WINDOW GLASS	23 BUILDINGS	496	143	5,985	374	GLAZIER	23	965	6.20
INSTALL FLOW RESTRICTING SHOWER HEADS & LAVATORY FAUCET INSERTS: FAMILY HOUSING	65 BUILDINGS	3,774	25,708	344,919	33,222	PLUMBER	868	58,301	5.90
FIX LEAKS IN BOILER PLANT PIPING	3 BUILDINGS	42	288	3,926	558	PLUMBER AND PLUMBER'S HELPER	6	834	4.71
INSTALL ROOF INSULATION: FAMILY HOUSING	BUILDINGS 2657, 8390, 8650, 8657	787	5,230	75,491	6,930	CARPENTER	300	17,333	4.35

TABLE 11-1

SUMMARY OF FACILITIES ENGINEER PROJECT DATA FOR USMC BAMBERG

PROJECT	LOCATION(S)	ENERGY SAVINGS PER YEAR (10^6 BTU)	DOLLAR SAVINGS PER YEAR	LIFE CYCLE SAVINGS	COST TO IMPLEMENT				STIR
					MATERIAL COST	MANHOURS		TOTAL COST (85 $)	
						TRADE	HOURS		
DECENTRALIZE DHW SERVICE DURING NONHEATING SEASON	BUILDINGS 7644, 7645, 7660 IN GY 150	1,213	7,873	121,180	22,134	STEAM FITTER	205	28,098	4.32
LAUNDRY WASHER WASTE HEAT RECOVERY	BUILDINGS 7047 AND 7098 IN GY 665	2,035	14,230	178,656	30,330	PLUMBER	415	42,321	4.21
CAULK AND WEATHERSTRIP DOOR AND WINDOW OPENINGS: FAMILY HOUSING	9 BUILDINGS	1,298	8,502	128,969	16,767	CARPENTER	493	31,853	4.03
LAUNDRY DRYER WASTE HEAT RECOVERY	BUILDINGS 7047 AND 7098 IN GY 585	685	4,890	58,351	15,262	SHEET METAL WORKER	193	20,717	2.81
INSTALL AUTO-CLOSING DEVICES ON EXTERIOR DOORS	38 BUILDINGS	282	1,979	24,716	7,443	CARPENTER	113	10,437	2.37
INSTALL DUAL-GLAZED WINDOWS: FAMILY HOUSING	BUILDING 7703	307	2,505	39,276	6,554	GLAZIER	436	19,800	1.99
INSTALL PHOTO CONTROL CELLS AND FLUORESCENT LAMPS IN EXTERIOR FIXTURES	214 BUILDINGS	3,280	18,666	205,513	38,078	ELECTRICIAN	2,658	118,615	1.73
INSTALL POWER FACTOR CORRECTION CAPACITORS	6 TRANSFORMER STATIONS	0	25,060	235,585	127,404	ELECTRICIAN	1,134	161,934	1.44
REPLACE EXTERIOR LIGHTING FIXTURE WITH PHOTOCELL-CONTROLLED FLUORESCENT FIXTURE	33 BUILDINGS	305	1,742	19,179	11,063	ELECTRICIAN	196	17,890	1.08

TABLE 11-1

Revision Instructions
Volume II: Appendices

1. Replace title page.

2. In Appendix F:

   a. Insert "Temperature Bin Data" sheet following existing material.

3. In Appendix J:

   a. Replace Table of Contents with revised sheet.

   b. Remove ECO No. M22A calculation set and insert in Appendix L.

   c. Remove ECO No. M45A calulation set and insert in Appendix L.

   d. Insert ECO No. E45A removed from Appendix K into Appendix J.

4. In Appendix K:

   a. Replace Table of Contents with revised sheet.

   b. Remove ECO No. M29A "Revision Calculations" dated 4 January 1984. Insert new ECO No. M29B calulation set following ECO No. M29A calculation set dated 30 June 1983.

   c. Replace ECO No. M29A title sheet.

   d. Remove ECO No. E46A calculation set from Appendix K and insert in Appendix J.

FINAL SUBMITTAL

VOLUME II: APPENDICES

ENERGY ENGINEERING ANALYSIS PROGRAM

BAMBERG MILITARY COMMUNITY

GERMANY

Prepared for

DEPARTMENT OF THE ARMY

EUROPE DIVISION, CORPS OF ENGINEERS

FRANKFURT, GERMANY

Prepared by

KELLER & GANNON

Engineers • Architects

1453 Mission Street

San Francisco, California, USA

MAY 1984

CONTRACT NO. DACA90-82-C-0204

APPENDIX F

TEMPERATURE BIN DATA

Yearly Heating Degree-Hours

	Degree-hours Per Design Temperature 1/		
Interval	72° F.	65° F.	55° F.
02 to 09	63,460	57,764	33,204
10 to 17	58,995	42,221	23,408
18 to 01	71,630	52,419	29,503
Totals	194,085	152,404	86,115

1/ Degree-hr totals are located based upon the TM5-785 Engineering Weather Data information for TEMPELHOF A3, BERLIN, GERMANY.

APPENDIX J

BACKUP DATA: ECIP PROJECTS

ECO NO. M03A AND M26A: NIGHT/WEEKEND SETBACK OF TEMPERATURE AND THERMOSTATIC RADIATOR CONTROLS; OUTSIDE AIR TEMPERATURE RESET ON HOT WATER HEATING SYSTEM

ECO NO. M04B: INSTALL FLOW RESTRICTION DEVICES

ECO NO. M05A: ISOLATE OFF-LINE BOILERS

ECO NO. E12A: INSTALL MORE EFFICIENT LIGHT FIXTURES

ECO NO. A16A: ROOF INSULATION

ECO NO. A18A: WEATHERSTRIPPING DOORS AND WINDOWS

ECO NO. M21A: REPAIR/REPLACE BOILER PLANT PIPING AND INSULATION

ECO NO. M21B: INSULATE VALVES IN BOILER PLANTS

ECO NO. M21C: REPAIR/REPLACE BOILER AND VESSEL INSULATION

ECO NO. M28A: SEPARATE MAKE-UP FOR EXHAUST HOODS

ECO NO. M32A: RECLAIM HEAT FROM FLUE GAS BOILER AIR PREHEATER (Deleted from ECIP project)

ECO NO. M33B: INSTALL OXYGEN TRIM CONTROLS ON BOILERS

ECO NO. M34A & B: INSTALL AUTOMATIC BOILER BLOW-DOWN WITH WASTE HEAT RECOVERY

ECO NO. E46A: ENERGY MONITORING AND CONTROL SYSTEM

Job

APPENDIX K

BACKUP DATA: NON-QUALIFYING PROJECTS

ECO NO. M03C: STEAM HUMIDIFICATION FOR BUILDING 7334

ECO NO. E09A: INSTALL SKYLIGHTS ON TOP FLOORS

ECO NO. A14A: EXTERIOR WALL INSULATION

ECO NO. A14B: MAINTENANCE BAY DOOR RETROFIT

ECO NO. M20A: REDUCE RESISTANCE TO FLOW IN HEATING DISTRIBUTION SYSTEM

ECO NO. M24A: EVALUATION OF DIFFERENT HEAT TRANSFER MEDIA

ECO NO. M29A: NATURAL-GAS FIRED RADIANT HEATING FOR SHOPS AND WAREHOUSES

ECO NO. M29B: STEAM/HOT WATER RADIANT HEATING PANELS

ECO NO. M33A: INSTALL BOILER FLUE GAS ECONOMIZERS

ECO NO. M36A: INSULATE DHW PIPING INSIDE BUILDINGS

ECO NO. M39A: SOLAR DHW HEATING FOR BARRACKS

ECO NO. E43A: UTILIZE MORE EFFICIENT TRANSFORMERS

ECO NO. E46B: POWER LINE CARRIER SYSTEM

ECO NO. M29A: NATURAL-GAS FIRED RADIANT HEATING FOR SHOPS AND WAREHOUSES

ECO No. 4293: STEAM/HOT WATER RADIANT HEATING PANELS

REVISION CALCULATION
COMPUTATION SHEET

Keller & Gannon
Engineers · Architects

COMPUTED BY B/H
CHECKED BY
DATE 4 JAN 1984
REV 23 MAY 1984

ECO K 29B
RADIANT HEATING OF
SHOPS & WAREHOUSES
STEAM OR HOT WATER PANELS

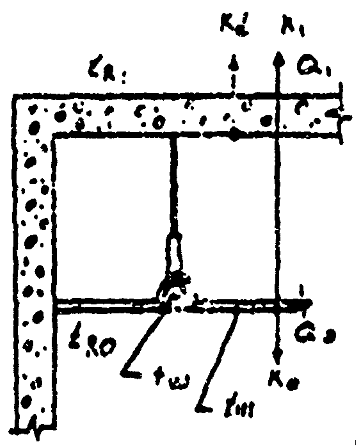
PROJECT BLDG. EEAP
16.464.01

SHEET NO 1 OF _ SHEETS

PURPOSE: REEVALUATE RADIANT HEATING PROJECT FOR SHOPS & WAREHOUSES EMPLOYING NEWLY DEVELOPED "ZENT-FRENGER" RADIANT HEATING SYSTEM. (REF. TRANSMITTAL OF 16 DEC 83 M. NOWICKI TO RCL)

HEAT LOAD: BASE HEAT LOAD UNDER DESIGN CONDITIONS FOR A REPRESENTATIVE MODEL BUILDING ON B.L.A.S.T. AND/AM-LOAD SIMULATION PROGRAM RESULTS.

FROM MANUFACTURER'S DATA:



t_{RO} = ROOM TEMP 55°F (12.8°C)
t_{Ri} = OUTSIDE TEMP (WINTER DESIGN)
K_o = U OF ASSEMBLY
K_d = U OF ROOF
T_W = AVG. HTG MEDIA TEMP.
T_M = AVG. PLATE TEMP
Q_o = HEAT TO SPACE
Q_1 = HEAT LOSS THRU ROOF

BLDG 3012 = ANALYSIS MODEL
212°F (100°C) STEAM
T_W (HW SYS) = 90°C to 60°C, AVG = 75°C

T_{Ri} = 13°F (−10.6°C)

THEN Q_o FOR A 100 MM × 600 MM PANEL IS:
(FROM MANUFACTURER'S DATA)

T_{RO}	Q_o	t_m (°C)
10°C	175	32.5
15°C	160	36.0
12.8°C	167	34.9

KCAL/h·m

REVISION
COMPUTATION SHEET

Keller & Gannon
Engineers · Architects

COMPUTED BY BJH	ECO M293	PROJECT EAUBERG ERAP
CHECKED BY		16-A14-01
DATE 4 JAN 19	RADIANT HEATING OF	
REV 25 MAY 1984	SHOPS & WAREHOUSES	SHEET NO 2 OF 9 SHEETS

STEAM OR HOT WATER PANELS

HEAT LOSS RATE THRU ROOF. BUILDING 3012

U = 0.24 BTU/SF HR °F

$$\frac{0.24\ BTU}{SF\ HR\ °F} \times \frac{0.453\ Kcal\ °F}{°C - BTU} \times \frac{SF}{0.0929\ m^2}$$

= 2.05 Kcal/m² Hr °C

$t_m - t_{R,}$ = 34.9°C - (-10.6°C) = 24.3°C

Q, Kcal/m²h = 17.5

COMPUTATION SHEET

Keller & Gannon
Engineers · Architects

COMPUTED BY RJH CHECKED BY DATE 25 MAY 1984 REV 19	ECO H29B - HV OR STM RADIANT HEATING - CEILING PANEL SYSTEM	PROJECT [illegible] FEAP 16-464-01 SHEET NO 3 OF 9 SHEETS

ENERGY SAVINGS CALCULATION

WITH EXISTING EQUIPMENT & PROPER THERMOSTATIC CONTROLS, THE BLOCK LOAD FOR THE ROOF IS 165,306 BTUH, OR 41,649 KCAL/HR.

WITH NEW RADIANT PANELS, THE BLOCK LOAD FOR THE ROOF IS

1531 M² × 17.5 = 26,793 KCAL/HR.
OR 106,339 BTUH

BLOCK LOAD SAVINGS IS THUS:

165,306 − 106,339 = 58,967 BTUH, OR
41,649 − 26,793 = 14,856 KCAL/HR

FACTORING FROM RESULTS OF H03A (NIGHT SET-BACK ECO) THE ANNUAL LOAD SAVINGS ARE:

58,967/(550,966 − 24,181) × 836×10⁶ BTU =
LOAD 93.6×10⁶ BTU/Y SAVED.

HEATING PLANT 7001, FUEL: NO.2 FO & COAL (COAL [illegible] / [illegible]) (FO [illegible] / 67 [illegible])
EFFICIENCY 59% INCLUDING DISTRIBUTION SYSTEM LOSSES.

ANNUAL FUEL COST SAVINGS:
COAL 0.664 (93.6) × 6.45 / 19.39 = 2879
NO 2 FO 0.336 (93.6) × 2.22 × 11.36 = 6218
} $8797 LCC SAVINGS

LIFE CYCLE FUEL COST SAVINGS:
= $ 8777

NOTE: SAVINGS 11%, about 4% ABOVE [illegible] CLAIM FOR [illegible] SAVINGS

ANNUAL MAINTENANCE COST

ASSUME THAT NEW EQUIPMENT REQUIRES NO MORE MAINTENANCE THAN DO EXISTING EQUIPMENT.

COMPUTATION SHEET

Keller & Gannon
Engineers · Architects

COMPUTED BY RJH
CHECKED BY
DATE 25 MAY 1984
REV 19

ECO H293 - HW 85TH
RADIANT HEATING - CEILING
PANEL SYSTEM

PROJECT BAMBERG EEAP
16-464-01

SHEET NO 4 OF 9 SHEETS

Q_o REPRESENTS HEAT TRANSFERED TO THE SPACE UNDER DESIGN CONDITIONS. THE BLOCK LOAD FOR B-7012 WITHOUT THE ROOF LOAD IS:

550,966 - 165,306 = 385,660 BTUH

THE AREA OF 600 MM x 600 MM PANELS REQUIRED IS THUS:

∴ 385,660 BTUH x 0.01757 x 14.34 = 97169 KCAL/HR

97,169 / 167 = 582 M^2 REQUIRED (= 6261 SF)

⇒ 1616 PANELS ARE NEEDED.

HOWEVER, CEILING MUST BE SEALED FROM ROOM SPACE TO AVOID MIXING OF AIR FROM ROOM WITH THAT IN THE SPACE ABOVE PANELS. THIS WILL ALLOW FULL ADVANTAGE OF INSULATING PROPERTIES TO BE REALIZED. ASSUME REMAINING AREA FILLED WITH "DUMMY PANELS" OF SAME SIZE: SAY 1620 HEATING PANELS

(16,468 - 6261)/(10.76 x 0.36) = 2635 DUMMY PANELS

TOTAL PANELS = 4255 PANELS.

COMPUTATION SHEET

Keller & Gannon
Engineers • Architects

COMPUTED BY RJH
CHECKED BY
DATE 25 MAY 1984
REV 19

ECO M29B: HW OR STM RADIANT HEATING - CEILING PANEL SYSTEM

PROJECT BAMBERG EEAP 16-444-01

SHEET NO 5 OF 9 SHEETS

COST ESTIMATE

THE FOLLOWING PROCEDURES/TASKS MUST BE PERFORMED

1. DISCONNECT EXISTING RADIATORS, AVERAGE 2 PER BAY.
2. REMOVE EXISTING RADIATORS AND DISPOSE.
3. CAP OPEN STM/COND SERVICE, EXTENT ONE STM/COND SERVICE TO ROOF AREA & INSULATE PIPING.
4. DISCONNECT EXISTING LIGHT FIXTURES & REMOUNT UNDER RADIATOR PANEL SYSTEM TOTAL 17 BAYS, 8 FIXTURES PER BAY = 136 FIXTURES
5. INSTALL NEW RADIATOR PANELS 600 mm x 600 mm EACH, TOTAL 4255 PANELS. ONE ANCHOR PER PANEL & AVG. ONE PIPE JOINT PER PANEL. - 1/2"Ø PIPING ON 2635 PANELS

ASSUMPTIONS:

1. DISCONNECT EXISTING RADIATORS: 2 CONNECTIONS EACH - 1½"Ø IRON PIPE 4 CONNECTIONS PER BAY, 17 BAYS: 4×17 = 68 CONNECTIONS (34 RADIATORS)
ASSUME 1 HOUR PER BAY, PLUMBER & APPRENTICE

PLUMBER \$20.95 × 1.2 = \$25.14 &
APPRENTICE \$16.75 × 1.2 = \$20.10
TOTAL \$45.24/HOUR

45.24/2 = \$22.62 PER RADIATOR

2. REMOVE & DISPOSE OF EXISTING RADIATORS
ASSUME COMMON LABORER 1 HR EACH \$14.35 × 1.2 =
EQUIP. OPER. (FORKLIFT) 0.2 HR EACH \$
PIPEFTR/PLUMBER

A

[illegible] "MEANS" HEAT [illegible] COST DATA 1983" & ADJUSTMENT FACTOR CALC

COMPUTATION SHEET

Keller & Gannon
Engineers • Architects

COMPUTED BY B/H
CHECKED BY
DATE 25 MAY 1986
REV

ECO H20B - H/W OR STM RADIANT HEATING - CEILING PANEL SYSTEM

PROJECT BLUEBERG EEAP 16-464-01

SHEET NO 6 OF 9 SHEETS

COST ESTIMATE CONTINUED ...

2. REMOVE EXISTING RADIATORS & DISPOSE
COMMON LABORER \$14.75 x1.2 = \$17.70/HR x 1 HR EA = \$17.70/RAD
EQUIP. OPER (ROCK LIFT) \$17.85 x 1.2 = \$21.42/HR x 0.2 HR = \$4.28
PLASTER/PAINTER (PATCH) \$17.85 x 1.2 = \$21.42/HR x 1 HR = \$21.42
TOTAL PER RADIATOR = \$43.40

3. CAP CONNECTIONS & EXTEND PIPE TO CEILING AREA.
ASSUME ALL 1½" STEEL PIPE (EXISTING)
1½" STEEL PIPE NEW
EACH AT TAKE OFFS.

CAP: MAT'L \$2.50 x 1.2 = \$3.00 EA
LABOR \$12.55 x 1.2 = \$15.06 EA

EXTENSION: ASSUME 20 LF x 34 INSTALLATIONS = 680 LF
HEADER 20 LF EA. BAY x 34 = 680 LF
TOTAL 1½" Ø CU = 1360 LF.
MAT'L PER LF: \$3.09 x 1.2 = \$3.70
LABOR PER LF: \$3.97 x 1.2 = \$4.76

"T"S 34 EA - 1 PER BAY (EACH) AT TOP *
MAT'L 4.39 x 1.2 = \$5.27
LABOR 23 x 1.2 = \$28

INSULATION: ASSUME 1½" Ø PIPE USE 1" CALSIL
MAT'L \$2.45 x 1.2 = \$2.94/LF
LABOR \$1.40 x 1.2 = \$1.68/LF

680 LF PIPING, ALLOW 2 LF PER CONNECTION TO FIX OLD PIPE (2 x 34 = 68 LF)
ALLOW 1 LF PER T (34 x 1 = 34 LF)

1360
68
34

1462

* "T"S FOR TAKEOFFS - 1½" x 1½" x 1½"
[illegible] 2/17 = [illegible] PER BAY
[illegible] ~ [illegible] EA BAY = 170 "T'S x 2 = 340 (3 A/L)

COMPUTATION SHEET

Keller & Gannon
Engineers · Architects

COMPUTED BY BJH
CHECKED BY
DATE 25 MAY 1984
REV 19

ECO M29B - HW OR STM RADIANT HEATING - CEILING PANEL SYSTEM

PROJECT [illegible] EEAP 16-464-01

SHEET NO 3 OF 5 SHEETS

COST ESTIMATE CONTINUED...

4. DISCONNECT & REMOUNT 860 LIGHT FIXTURES.

DISCONNECT & REMOUNT:
ASSUME: LABOR 0.3 HRS EACH / ELECTRICIAN
(DRILL HOLE THRU PANELS, / APPRENTICE
CUT WIRE, STRIP; ATTACH GASKET,
STRIP & REWIRE)

LABOR: ELEC. $21.20/HR x 1.2 = $25.44/HR x 0.3 = $7.63 EA
APP. $14.45 x 1.2 = $17.34 x 0.3 = 5.20
TOTAL $12.83 EA

MATERIAL: ALLOW FOR GASKET & WIRE NUTS, ETC
$1.00 EACH FIXTURE

5. INSTALL NEW RADIANT PANELS
(MATERIAL COSTS UNKNOWN AT THIS TIME,
A VERY LOW ALLOWANCE PER PANEL IS ASSUMED
TO BE $1.00 PER PANEL - SINCE THIS PROJECT
WILL NOT PROVE ECONOMIC (PRELIMINARY INSPECTION
OF RESULTS INDICATES INVESTMENT RATIO ABOVE
EXCEEDS LCC FUEL SAVINGS).

PIPE HANGERS - 1 PER PANEL - DRILL HOLE
IN CONCRETE SLAB ROOF, ATTACH ANCHOR, TO
CEILING & THEN PANEL & LEVEL
(MAT'L COST NEGLECTED - ASSUMED HARDWARE
COMES WITH PANEL)
LABOR $2.20 x 1.2 = $2.64 EA. TO ATTACH TO PANEL.
ASSUME THIS INCLUDES ATTACHING HANGER
TO PANEL & CEILING, IN ADDITION TO
LEVELING PANELS & INSTALLATION.
(THIS IS EXTREMELY CONSERVATIVE)

CONNECT PIPING BETWEEN PANELS - EQUIV OF
LABOR FOR STEEL COUPLING: $12.95 EACH.
SEEMS HIGH - REDUCE TO $2.00 EACH.

CONSTRUCTION COST ESTIMATE	DATE PREPARED 23 MAY 84	SHEET 8 OF 9

PROJECT: ERAP FOR USMC BAMBERG M39B

LOCATION: USMC BAMBERG

ARCHITECT ENGINEER: [illegible]

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. —

ESTIMATOR: B / HORST

CHECKED BY: RCL

CONSTR. COST SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
1. DISCONNECT EXIS. RADIATORS	34	E.	22.62	769	—	—	$ 769
2. RECONNECT/DISCHGE. RADIATORS	34	EA	42.40	1426	—	—	1426
3. CAP / EXTEND PIPING:							
CAP 1½" STEEL PIPE.	34	EA	15.06	512	3.00	102	614
EXTEND ½" STEEL PIPE.	1360	LF	4.76	6474	3.70	5032	11,506
T" 1½" STEEL	34	EA	28	952	5.27	179	1131
INSULATION 1"	1462	LF	1.68	2456	2.94	4298	6754
REDUCING T's 1½ × ½ × 1½	340	EA	28	9520	5.27	1792	11,312
4. [illegible]	136	EA	11.92	1265	1.00	136	1651
5. [illegible]	4255	EA	2.64	11,233	1.00	4255	15,488
[illegible]	1620	EA	2.00	3240	—	—	3240
SUBTOTAL							54,131
CONTRACTOR OH & PROFIT 30%							16,251
SUBTOTAL							70,422
BOND 1%							704
SUBTOTAL @ 2.40 DM/$							71,126
ADJUST TO 2.52 DM/$							67,739
ESTIMATING CONTINGENCY 5%							3,387
TOTAL CONSTRUCTION COST							$ 71,126

ENG FORM 150 1 OCT 80 (ER 1110-345-720) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: USMC BAMBERG REGION NO. 11 PROJECT NUMBER M298

PROJECT TITLE INSTALL STM/HW DAD. HTG. IN SHOPS FISCAL YEAR 87

DISCRETE PORTION NAME DIST CASE FOR BUILDING 7012

ANALYSIS DATE 11/84 ECONOMIC LIFE 15 YEARS PREPARED BY KELLER-EGGLITON

1. INVESTMENT
   A. CONSTRUCTION COST $ 21,126
   B. SIOH 5.5% $ 1,162
   C. DESIGN COST 6% $ 1,268
   D. ENERGY CREDIT CALC (1A+1B+1C)X.9 $ 21,335
   E. SALVAGE VALUE -$ 0
   F. TOTAL INVESTMENT (1D-1E) $ 21,335

2. ENERGY SAVINGS (+) / COST (-)
   ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$ 7.23	31.4	$ 227	11.25	$ 2539
C. RESID	$		$		$
D. NG	$		$		$
E. COAL	$ 6.50	62.2	$ 404	15.37	$ 6215
F. TOTAL		93.6	$ 621		————> $ 8797

3. NON ENERGY SAVINGS(+) / COST(-)
   A. ANNUAL RECURRING (+/-) $
      (1) DISCOUNT FACTOR (TABLE A)
      (2) DISCOUNTED SAVING/COST (3A X 3A1) $

   B. NON RECURRING SAVINGS(+) / COST(-)

ITEM	SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST(-)(4)
a.	$			$
b.	$			$
c.	$			$
d. TOTAL	$			$

   C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+) / COST(-) (3A2+3Bd4) $

   D. PROJECT NON ENERGY QUALIFICATION TEST
      (1) 25% MAX NON ENERGY CALC (2F5 X .33) $ —
         a IF 3D1 IS = OR > 3C GO TO ITEM 4
         b IF 3D1 IS < 3C CALC SIR = (2F5+3D1)÷1F= —
         c IF 3D1b IS = > 1 GO TO ITEM 4
         d IF 3D1b IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3Bd1÷YEARS ECONOMIC LIFE) $ 621

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 8797

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALIFY) (SIR)=(5÷1F)= [illegible]

zent-frenger FABRIKSTR. 31 · POSTF. 183 · 6140 BENSHEIM 1

European Engineer Division
c/o Mr. Brettschneider
Phillips-Bldg.
Lübecker Straße 31

6000 Frankfurt/Main

Ihre Nachricht	Ihre Zeichen	Unser Zeichen	Durchwahl	Tag
-	-	tw/hd	213	15.12.1982

Dear Sir,

we would like to present our ZENT-FRENGER Radiant Heating System. This system is based on a suspended metal ceiling. The metal ceiling is fixed to a grid of 1/2" pipes which are connected with the heating system. Through the direct contact between pipe and ceiling there is no time-lag in the heat transfer. Radiant heating is very precise and rapid to control which results in an excellent energy economy.

In addition to its economical feature the ZENT-FRENGER Radiant Heating System performs as an acoustic ceiling of high quality - an ideal combination - heating and sound absorption - is achieved.

We would like to brief you personally about the advantages of our system and about the various possible installations. Please let us know which date is convenient for you.

Sincerely,

ZENT - FRENGER
Strahlungsheizung GmbH

F. Wehlund

Enclosures
Brochure

The "ZENT - FRENGER" Radiant Ceiling heating system is manufactured by the "ZENT - FRENGER - Strahlungsheizung GmbH", at D 6140 Bensheim, Federal Republic of Germany. Their program contains also the "ZENT - LAMELLA" radiators and the compact heating units "ZIERAL".

For more than 25 years the "ZENT - FRENGER" Radiant Ceiling Heating System is built as a chassis bearing water pipes, the chassis being detached from the blank ceiling. The intervals between the pipes are varying. The heat transfer is done by a metallic contact between the pipe system and the cassette or the panel. The varying heat demand is compensated by controlling the water temperature which allows to attain the required heat quantity. Visible or space requiring faces will not be found within halls and rooms built for personal purposes.

This heating system has already proven successful in all kinds of halls, gymnasiums, covered courts, covered swimming pools, baths, sport installations and halls for recreational purposes. According to DIN 18032 the construction has been tested by the Federal Institute for Sport sciences, Lövenich near Cologne, as Closing structures secure to thrown balls respectively high mechanical stress.

It is very important for the personal well-being and for the determination of heat quantity, to control the average room temperature and the temperature of all closing surfaces. Only by that manner the comfort of a room or hall can be taken into consideration, but in all previous indoor climatic tests this fact has not found the interest it should be given to.

These facts and other results are, however, taken fully into account for the "ZENT - FRENGER" Radiant Ceiling Heating. The preferred uniform underfloor heating for floor exercises has a very favourable aspect in this concept.

Of great advantage are the short heating-up time and the precise and rapid control. The Radiant Ceiling Heating shows merely a very light air flow. Compared with other heating systems, especially as regards the filtering action, the "ZENT - FRENGER" Radiant Ceiling Heating has been recognised to be absolutely perfect with respect to hygiene. The temperature difference between the floor and 2 meters of room height is very low in comparison with convection heating installations.

Obviously the "Zent - FRENGER" Radiant Ceiling Heating system and its energy economy become to-day a very essential factor, as equal conditions prevailing applied to operating times and boiler effaciency allow to save up to 15% of running costs.

Moreover the "ZENT - FRENGER" Radiant Ceiling Heating serves as an sound absorbing ceiling (acoustics) of high quality so that an ideal combination - heating and sound absorbing - is achieved.

As energy economy is concerned the recently published directions are laying down to equip sport halls with static heating systems and that for economy reasons. After these instructions have been issued for Germany there is no doubt that further directions of the same kind will certainly follow for other groups of public buildings and installations. With regard to the architectural design the "ZENT - FRENGER" Radiant Ceiling Heating system fulfills also all requirements.

Plate dimensions from 600 x 600 mm up to 300 x 600 mm or panel widths from 85 to 92 mm having different joint widths are offering a great number of possibilities for ceiling design. This system can also receive integrated light fixtures and obviously lamps specially appropriated to covered sport installations. Colour designing of the ceiling undersides will not encounter any difficulties. Its good heating power and sound absorbing efficiency will also justify to use the "ZENT - FRENGER" ceiling plate for sound absorbing purposes. Tests have already been carried out on an official base, see DIN 52212.

All experience and results with the "ZENT - FRENGER" Radiant Ceiling Heating collected by our technical staff for more than 30 years and on an international level are available for planning offices, consulting engeneers, building owners and all industries interested in the technical progress.

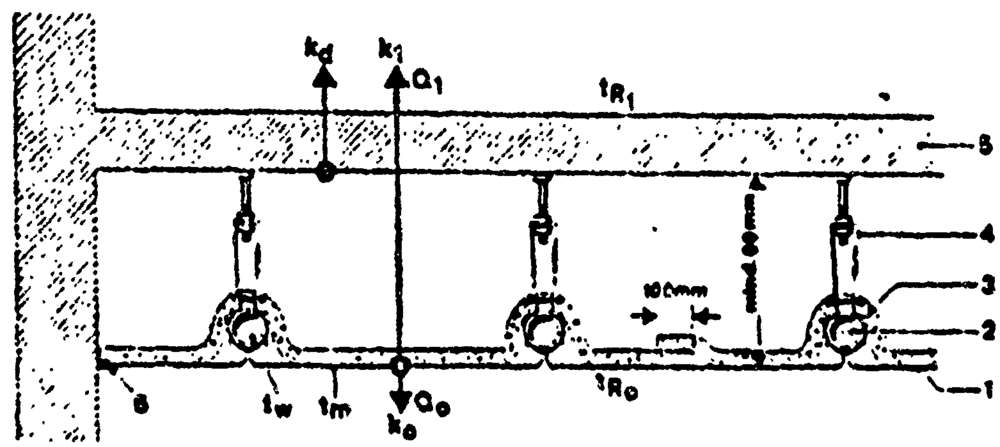
Please ask for "Technical documentation":

ZENT - FRENGER
Strahlungsheizung GmbH
P.O.Box 183
Tel. (06251) 17-1
FS 0468406
6140 Bensheim 1

BERECHNUNG DER DECKEN-HEIZFLÄCHE

Die Zent-Frenger-Strahlungsheizung — Kassettendecke — besteht aus Aluminiumplatten gelocht oder ungelocht an Rohrregistern mit Aufhängung, Isolierung und Randleiste. Die Abb. 1 zeigt einen Schnitt durch die Zent-Frenger-Decke. Der Montageabstand von der Rohbaudecke ist beliebig. Minimal jedoch 80 mm vom tiefsten Punkt der Rohbaudecke bis Unterkante Aluminiumplatte (Abb. 1).

Abb. 1



- t_{Ro} = Raumtemperatur °C
- t_{R1} = Temperatur des darüberliegenden Raumes °C
- k_o = Wärmedurchgangszahl nach unten kcal/m² h grd
- k_1 = Wärmedurchgangszahl nach oben kcal/m² h grd angenommen k_1 = 0,5 kcal/m² h grd
- k_d = Wärmedurchgangszahl der Tragdecke angenommen k_d = 0,8—1,2 kcal/m² h grd
- t_w = mittlere Wassertemperatur °C
- t_m = mittlere Plattentemperatur °C

- Q_o = Wärmeabgabe nach unten kcal/m² h
- Q_1 = Wärmeabgabe nach oben kcal/m² h
- 1 = Aluminiumplatten
- 2 = Rohrregister ½" mit Vierkantverteilerrohr 25 mm
- 3 = Isolierung
- 4 = Aufhängung
- 5 = Tragdecke
- 6 = Randleiste

Lieferbare Plattengrößen	625 × 625 / 600 × 600	
	500 × 500 / 400 × 600	
	300 × 600 mm	Sondergrößen auf Anfrage.

Als Grundlage dient die Wärmebedarfsberechnung nach DIN 4701. Die Wärme der Aluminiumplatte wird nach unten — Q_o — und nach oben — Q_1 — abgegeben. Aus den Diagrammen — A bis F — ist die Wärmeabgabe — Q_o — nach unten an den Raum bei verschiedenen Raumtemperaturen ersichtlich,

$$t_{Ro}\ (+10°,\ +15°,\ +18°,\ +20°,\ +22°,\ +25°\ C)$$

und den mittleren Wassertemperaturen

$$t_w = \frac{t\,\text{Vorlauf} - t\,\text{Rücklauf}}{2} \quad \text{für } t_w = 30°\ \text{bis}\ 100°\ C$$

Da die Wärmeabgabe — Q_1 — von der Temperatur des darüberliegenden Raumes abhängig ist, enthalten die Diagramme drei verschiedene Temperaturwerte für t_{R1} (t_{R1} = 0° — 10° — 20° C). Gleichzeitig ist die mittlere Plattentemperatur — t_m — abzulesen. Die Werte — Q_o — für einen Rohrabstand von 100 mm bzw. 600 mm sind in den Diagrammen getrennt aufgeführt.

Zur Bestimmung der Wärmeabgabe — Q_o — entsprechend aufgeführter Plattengrößen ist der aus den Diagrammen abzulesende Wert — Q_o — der Plattengröße 600 × 600 mm mit folgenden Werten zu ermitteln:

625 × 625 mm	Q_o × 0,96
500 × 500 mm	Q_o × 1,20

BERECHNUNG DER DECKEN-HEIZFLÄCHE

Die mittlere Plattentemperatur — t_m — ist vom neu errechneten Wert — Q_s — aus abzulesen. Die physiologisch zulässige Plattentemperatur (siehe Tabelle) darf nicht überschritten werden.

Bei anderen als in den Diagrammen — A bis F — aufgezeigten Raumtemperaturen können die Werte — Q_s — durch Verschieben der Skala — t_m — gefunden werden.

Z. B. für $t_{R_A} = 24°C$ wird im Diagramm D für $t_{R_A} = 20°C$ statt mit t_m 80° C mit t_m 76° C gerechnet. Es ergibt sich dann eine Wärmeabgabe — Q_s — = 157 kcal/m² h.

In der Wärmebedarfsberechnung darf der Wärmeverlust der Tragdecke nach oben im beheizten Teil nicht eingerechnet werden. Die erhöhte Wärmeabgabe der Zent-Frenger-Decke ist in unseren Diagrammen für Temperaturen $t_{R_1} = \pm 0°$, — 18°—20° C bereits berücksichtigt. Dagegen ist der Wärmegewinn eines im darunterliegenden Raum montierten Zent-Frenger-Decke in Anrechnung zu bringen.

Bei der Auslegung der Deckenheizflächen bleibt der Transmissionsverlust der Tragdecke (Rohbaudecke) unberücksichtigt, wenn die Wärmedurchgangszahl der Rohbaudecke unter dem Wert k = 1,0 kcal/m² h grd liegt. Für die Berechnung des Rohrleitungsnetzes ist mit der Gesamt-Wärmeabgabe, also der Wärmeabgabe der Zent-Frenger-Decke nach unten und oben zu rechnen.

Physiologisch empfehlenswerte Plattentemperaturen — t_{R_i} = 18° bis 20° C

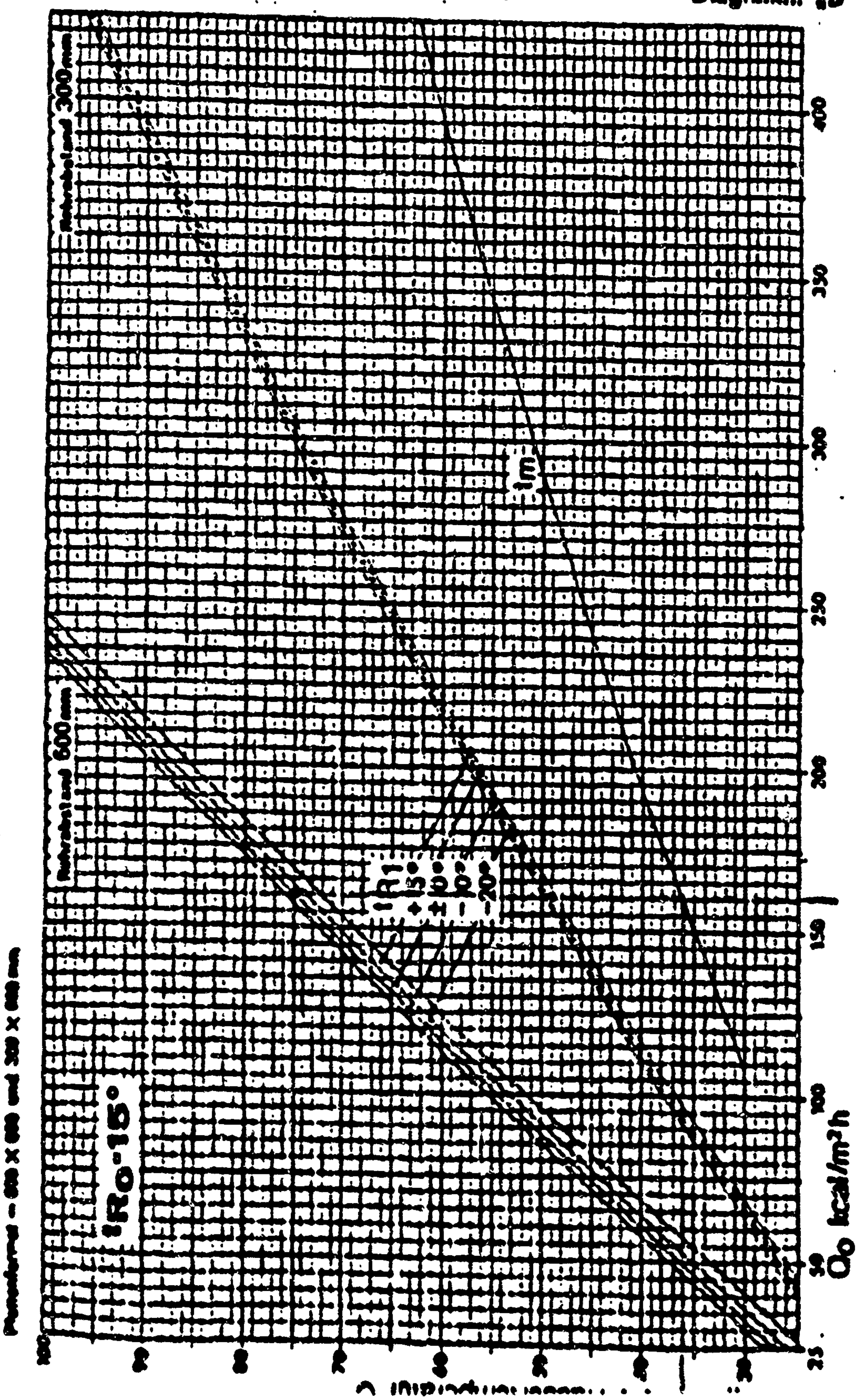
Raumhöhe in m	Wärmeabgabe ca. Q. kcal/m² h	mittlere Plattentemperatur in °C
2.20	80-114	31.0-33.5
2.40	90-131	32.5-35.0
2.60	105-150	34.0-37.0
2.80	120-164	36.0-39.0
3.00	140-180	38.0-41.0
3.00	165-200	41.0-43.0
3.20	180-217	43.0-45.0
3.50	218-230	46.5-48.0
3.90	273-300	52.5-54.0
4.50	300-340	57.5-59.0
5.00	430-460	67.5-68.5

Bei größeren Raumhöhen sind die in der Aufstellung angeführten Werte nicht als Soll-, sondern als höchstzulässige Werte zu betrachten.

Zur Deckung des Wärmebedarfs eines 5,0 m hohen Raumes sind im allgemeinen Wärmeabgaben von 150 bis 200 kcal/m² h völlig ausreichend.

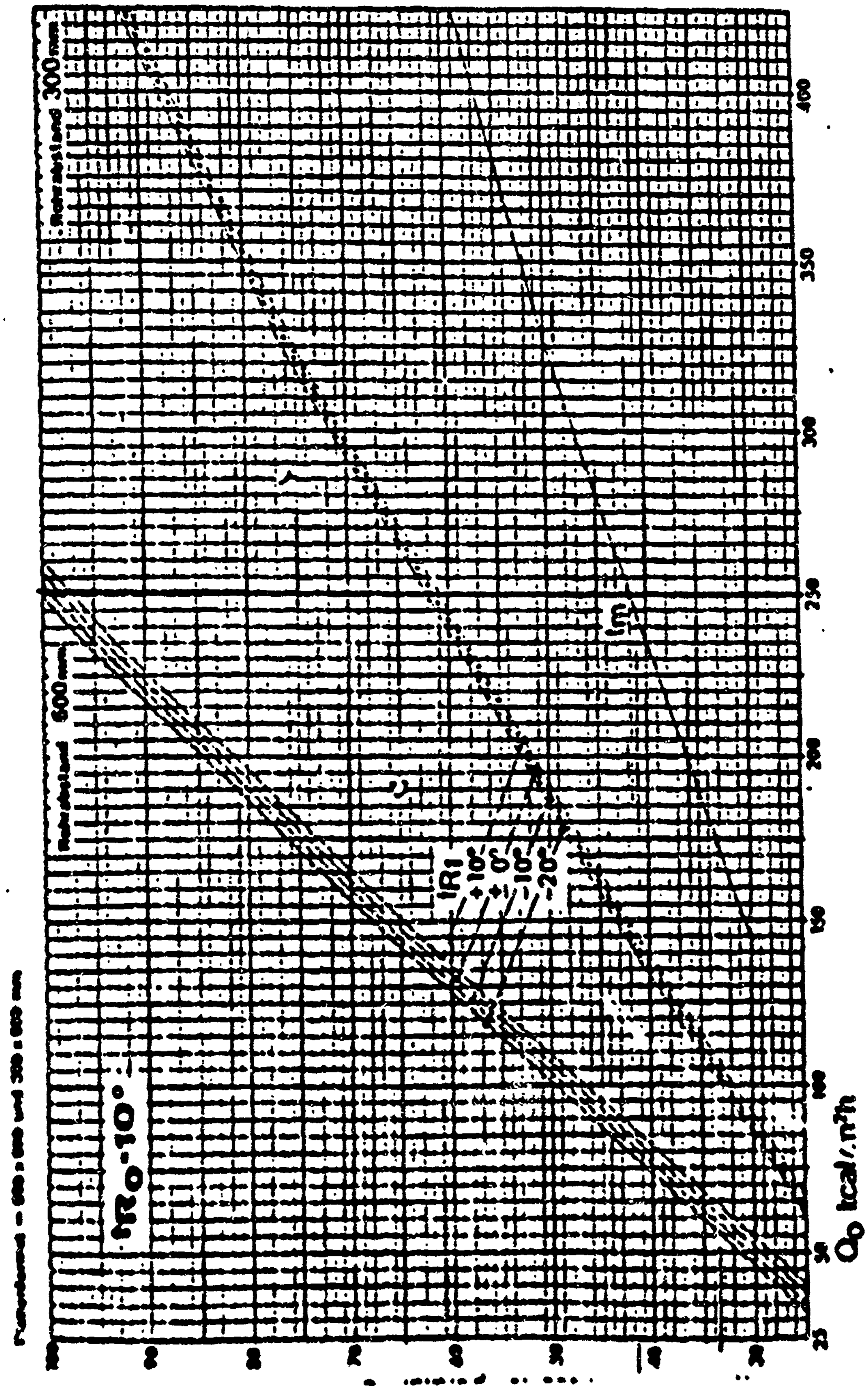
Wärmeabgabe - Q_o - nach unten

Diagramm „B"



Wärmeabgabe - Q_o - nach unten

Diagramm „A"

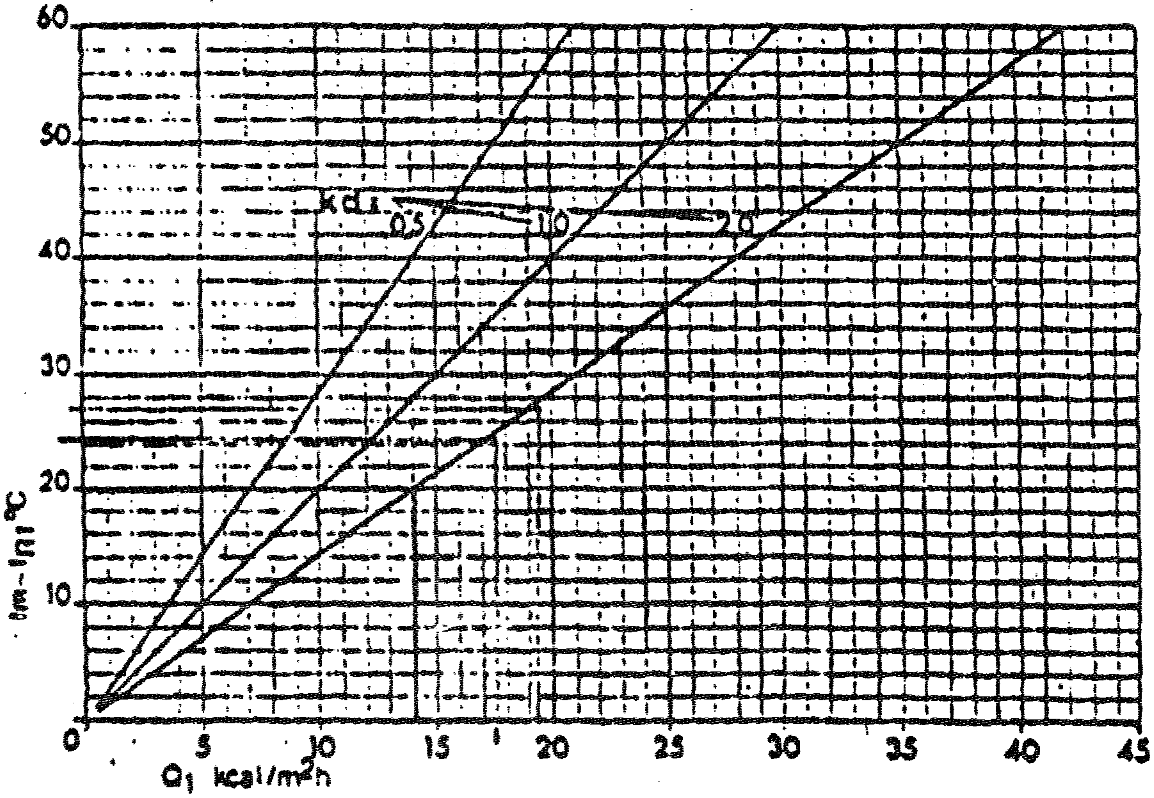


BERECHNUNG DER DECKEN-HEIZFLÄCHE

Abb. 2 gibt die Wärmeabgabe nach oben — Q_1 — an, die abhängig ist von der mittleren Plattentemperatur — t_p — des darüberliegenden Raumes — t_{a1} — bei verschiedenen Wärmedurchgangszahlen — k_d — der Tragdecke. Wenn die Raumtemperatur — t_{a0} — gleich der Temperatur des darüberliegenden Raumes — t_{a1} — ist, beträgt die Wärmeabgabe — Q_1 — nach oben ca. 8 %.

Abb. 2

Wärmeabgabe - Q_1 - nach oben



t_{a0} = Raumtemperatur °C

t_{a1} = Temperatur des darüberliegenden Raumes °C

k_0 = Wärmedurchgangszahl nach unten kcal/m² h grd

k_1 = Wärmedurchgangszahl nach oben kcal/m² h grd

k_d = Wärmedurchgangszahl der Tragdecke kcal/m² h grd

t_w = mittlere Wassertemperatur °C

t_p = mittlere Plattentemperatur °C

Q_0 = Wärmeabgabe nach unten kcal/m² h

Q_1 = Wärmeabgabe nach oben kcal/m² h

Die Isolierung an Dächern oder sonstigen horizontalen Außenfronten muß eine gute Wärmedämmung garantieren.

Es ist besonders darauf zu achten, daß Schwitzwasserbildung vermieden wird.

Wir empfehlen in solchen Fällen einen Fachingenieur